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with the untutored savage." Even the enjoyments of life are multiplied and enhanced by a knowledge of Chemistry, and its evils diminished. The works of nature, which others view with indifference, and regard as mere confused masses and rubbish, the chemist finds endowed with a beautiful regular organization, and of great importance to the world of created beings. To him every thing, however trifling and insignificant it may appear to others, is interesting. He investigates with peculiar pleasure the varied works of nature, and through nature sees Nature's God.

To facilitate an acquaintance with the Science of Chemistry, the author has been induced to publish this Work. In Medicine he has been particularly fortunate in establishing a rational system, by the publication of the MEDICAL GUIDE, and DICTIONARY OF POPULAR MEDICINE. In the present work he has adopted the same plan of arranging the articles in numerical order, to correspond with a PORTABLE CHEST OF CHEMISTRY, which he flatters himself will

render the study more simple and more interesting to the young student.

For the very flattering marks of public favour the author has received in his other works, and the support his MEDICAL AND CHEMICAL HALL has met with from the first chemical characters in this kingdom, he begs to return his most cordial thanks, and to assure his friends that it will ever be an object of ambition with him to merit a continuance of their patronage.

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Philosophers in every age have been of opinion, that notwithstanding the great diversity and multiplicity of bodies in nature, they are all composed or constituted of a few primary simple substances, to which they have given the name of elements. But they have always differed about the number and the nature of these principles. Earth, air, fire, and water, have been for many ages considered as the sole principles of all things, but chemistry now teaches us that there are different kinds of earths, different kinds of air, that fire is a simple substance, and that water is a compound.

Having premised this much, it may be proper

to explain what is meant by the term element or simple substance. Simple substances are bodies separated in analysis, and capable of no further decomposition, or of being reproduced by artificial means. The number of substances at present considered as elements, amounts to near fifty, but it does not follow that these bodies are absolutely simple, but are so according to the present state of our knowledge; but as the science advances towards perfection, we shall on the contrary no doubt find many of them to be compound. They may be classed in the following order.

Table of Simple Substances, which may be considered as the Chemical Elements of all Bodies in the Three Kingdoms of Nature.

Light.

Caloric . .	Igneous fluid, Principle, or Element of Heat.
Oxygen . .	Base of Vital Air, Dephlogisticated, or Empyreal Air.
Azot . . .	*Synon.* Nitrogen, Base of Phlogisticated Air.

Hydrogen—Base of inflammable Air or Gas.
Muriatic Radical—Base of Muriatic Acid.
Fluoric Radical—Base of Fluoric Acid.
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Simple Combustible, Oxydable, Metallic Substances.

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Cerium, *acidifiable.*
Chrome, *acidifiable.*
Cobalt.
Columbium, *acidifiable.*
Copper.
Gold.
Iridium.
Iron.
Lead.
Manganese.
Mercury.
Molybdena, *acidifiable.*
Nickel.
Osmium.
Palladium.
Platina.
Rhodium.
Silver.
Tantalium.
Tellurium.
Tin.
Titanium.
Tungsten, *acidifiable.*
Uranium.
Zinc.

Such are the bodies which we at present venture to term simple, and to which chemical writers have given the name of Radicals. To see the endless variety of created beings which nature presents to our view, composed from so few elementary substances, and that in the composition of the greater number not more than six or eight

of these are known to enter, it cannot fail to strike with admiration a reflecting mind.

It is further to be observed, chemical analysis has not yet probably proceeded all the lengths at which it may hereafter arrive. Many of the substances we now consider simple, may, and in all probability will, in time, be proved to be compounds, as the alkalies have recently been, and that possibly the ingenuity of man may never be able to reach the ultimate elementary particles of bodies.

DEFINITION OF CHEMISTRY.

THE grand object of Practical Chemistry is,

1st. To discover the component or constituent parts of every thing that surround us.

2ndly. Their mutual action upon each other.

3rdly. To reunite or form them into new combinations.

4thly. To know the nature of such combinations; and

5thly. The laws by which such combinations take place.

The theory of chemistry must, therefore, agreeably to this definition, consist in a complete knowledge of the phenomena that result from the various combinations and decompositions to which its different objects are exposed. All chemical operations are performed either by analysis or by synthesis.

Analysis is the separation of the elementary principles of a compound body; or, in other words, the separating from a heterogenous substance its homogeneous parts.

Synthesis is exactly the reverse of analysis; it denotes the formation of compound substances, by the combination of elementary bodies.

Analysis is either perfect or imperfect; it is termed a perfect analysis when we can by synthesis reproduce the substance by the union of the products of the analysis; but when this cannot be effected, it is termed imperfect.

The decomposition of sulphuret of mercury affords an instance of perfect analysis, as by a synthetical process this preparation may be brought to its original state. But in the analysis of a piece of wood, the reproduction of that substance will be impossible. As the arrangement of its structure is destroyed, a peculiar kind of aeriform fluid escapes, leaving a carbonaceous residuum; this presents us with an instance of complex or imperfect analysis.

The various combinations and decompositions which chemistry presents to our view, are the result of an innate power which they possess, entirely unknown to us. On this power depends the phenomena of the universe, it actuates the most minute as well as the most enormous masses of matter, but it acts differently according to the mass, consistency, and distances of the bodies subject to its influence; this certain, though unknown power, which every philosopher contemplates,

and which even the ignorant views with admiration, has been figuratively termed

ATTRACTION.

All bodies in nature have a natural proclivity to attract each other, they search as it were, and make efforts when left to themselves, to approach one another; that this power in reality exists, is obvious from the slighest view of the phenomena of the universe. It is an established truth, that the celestial bodies which constitute the solar system, are kept in their situations by it. It may also be evinced by the following Experiments:

EXPERIMENT 1.

Place upon a dry and smooth surface two or more globules of mercury, by gently pushing them the globules will attract each other, and form one mass, greater in bulk, but the same in nature.

EXPERIMENT 2.

A piece of gold or silver, immersed in mercury, and drawn out quickly, the mercury will attract the metal, and adhere to it so obstinately, as to be inseparable by friction.

EXPERIMENT 3.

If a piece of sugar be placed upon a few drops of water, on a table, it will speedily be attracted by the sugar.

EXPERIMENT 4.

If a piece be pared of two leaden bullets, and they are presented to each other with smooth surfaces, we shall find a mutual attraction.

EXPERIMENT 5.

By dipping a stick in water, we observe a drop hanging upon it in a spherical form, in consequence of the particles of the fluid exerting an equal force in every direction. This affords a very striking instance of the power of attraction.

REPULSION

Is a name given to a power directly opposite to that of attraction, and the cause of its force is equally inscrutable. If a piece of iron be placed upon a basin of mercury, it will not sink, but remain supported by it, while the mercury is depressed on each side. On the same principle a small needle swims upon the surface of water, but the greatest instance we have of chemical repul-

sion is in the particles of caloric, for in consequence of these repelling each other, the cohesion of the integrant parts of bodies become diminished; thus solids are converted into liquids, and liquids into a state of aeriform fluidity.

Attraction therefore appears to be the tendency that all bodies have to come into union or apparent contact; while repulsion is an opposite power which they possess, giving them a propensity to recede from each other.

ATTRACTION OF AGGREGATION.

Attraction of aggregation, sometimes termed, attraction of cohesion, or corpuscular attraction, is the power by which every thing in nature is kept from falling to pieces. It exists always between particles of the same nature, whether simple or compound; thus it holds together the particles of a piece of metal, which is a simple substance, as well as the particles of a glass bottle, which is a compound.

Melt together, for example, two pieces of wax, or two pieces of lead, they will form an uniform mass, the particles of which are held together by the power of attraction; this affords us also an instance of repulsion, the heat interposed between the particles of the wax or the lead, and

rendered them fluid, in which state a union takes place; but the moment they are removed from the influence of heat, attraction instantly begins. We must therefore consider this coherent power as a greater or less approximation between their similar particles, for it is well known they are not in actual contact, but on the contrary an intermediate space is between them; from this circumstance we account for porosity. Agreeably to this law we must reckon four species of aggregates, the "Solid," as metals, &c.; the "Soft," as jellies, unguents, &c.; the "Liquid," as water, oils, &c.; and the "aeriform," as air, vapor, and the different gasses.

But as the natural state of all bodies is that of solidity, or where the attraction of cohesion predominates, we may venture to take for granted that caloric is the power of repulsion, and that it is the universal cause of fluidity; indeed there is reason to believe, was it not for the energy of this subtle fluid*, the whole matter of the universe would be condensed into one solid mass. Water for instance, by depriving it of part of its natural heat, speedily assumes a solid state; nay, even

* We venture the use of this expression, as caloric or elementary fire possesses all the properties of a fluid

mercury, which remains fluid at all temperatures of our atmosphere, may, by an artificial deprivation of its caloric, be brought to a solid mass. While on the other hand, ice, mercury, and even the most perfect metals, may by its repulsive power be dissipated in the state of vapor.

The attraction of aggregation may also be annihilated by mechanical means, but it requires a force superior to that by which its particles are already held together. The means generally employed are cutting, filing, pulverizing, &c. Hence the difficulty of cutting diamond, marble, &c.

A body that has once lost its power of attraction, by these means, is termed a DISREGATE.

ATTRACTION OF COMPOSITION,

OR

CHEMICAL AFFINITY.

WE observed that the preceding species of attraction exists only between homogenous particles, or particles of the same nature; whereas the attraction of composition or chemical affinity is only between heterogenous particles, or particles of a dissimilar nature, as acids unite with alkalies, alkalies with sulphur, metals with acids, &c.

Attraction of composition is governed by nine general laws, but previous to our entering upon these, we shall endeavour to exemplify what is meant by

CHEMICAL ACTION.

The phenomena that result from a proper application of different bodies, are founded on certain agencies inherent in all matter. Our object

therefore in the following experiments is to advance some palpable, positive, and negative proofs, to shew that wherever chemical action takes place, the properties of bodies become altered, and their individuality destroyed.

EXPERIMENT 1.

Fill a wine glass three parts full with water, and add to it a tea-spoonful of carbonate of magnesia, the powder will fall to the bottom, and no action whatever will take place but on the addition of an acid, as the sulphuric acid, a violent effervescence immediately follows, the magnesia is dissolved with rapidity, and the whole rendered perfectly limpid; in this experiment the nature of both the acid and the magnesia are destroyed, and a new compound is formed.

EXPERIMENT 2.

Into a tumbler put about an ounce of the solution of carbonate potash, and pour upon it half an ounce of sulphuric acid, a violent commotion takes place, and the produce is a solid salt; this experiment is the more striking, as both substances were in a fluid state, the salt formed will be found to have neither the sourness of the acid, nor the causticity of the potash.

EXPERIMENT 3.

Mix equal parts of muriate of ammonia, and lime, both of which are destitute of smell; they produce a compound extremely pungent.

EXPERIMENT 4.

Add to a solution of oxymuriate of mercury, a little of the solution of carbonate of potash, both of which are colorless, but in mixing them a dark orange colored precipitate is formed.

EXPERIMENT 5.

Add to the orange colored mixture, formed in the last experiment, some muriatic acid, its primitive transparency and limpidity are immediately restored.

EXPERIMENT 6.

Shake together in a vial some olive oil and water. No action will take place, as the oil will be seen instantly to separate, but on the addition of an alkali, as the solution of pure potash, a union immediately takes place, and a saponaceous compound is found, a chemical action

has here taken place, and the properties of the oil, the water, and the potash, are entirely lost.

EXPERIMENT 7.

Upon half an ounce of oil of turpentine pour about an ounce of nitrous acid. Combustion immediately ensues.

EXPERIMENT 8.

Mix equal parts of oxymuriate of potash, and sugar, and let fall upon it a single drop of sulphuric acid, and the whole instantly bursts into flame.

EXPERIMENT 9.

By mixing equal parts of sulphuric acid, and water, a degree of heat is disengaged sufficient to make water boil.

These experiments are merely advanced to shew that the properties of different substances become destroyed, when they are presented to each other, under such circumstances as experience has taught us are necessary to produce such effects.

CHEMICAL ATTRACTION.

CHEMICAL attraction—chemical affinity, or affinity of composition, is the power by which bodies of a dissimilar nature, whether simple or compound, attract each other so intimately, as to form an homogeneous whole. The particles of certain bodies seem as it were to have a preference to particular menstrua; thus, if to a solution of silver in nitric acid, a few strips of copper are added, it will let fall the silver and take up the copper, and if an alkali be added, it will let fall the copper, and unite with the alkali; the body thus thrown down, is said to be precipitated, and is called a precipitate; the substance employed to cause the precipitation is termed a RE-AGENT.

It is therefore clear that the particles of bodies united by virtue of chemical affinity, form not a mere aggregate, but a new substance, which cannot be altered only by the action of another chemical agent. Hence it becomes of the greatest importance, as it takes place in all the complex operations of chemistry. It will be unnecessary to offer further proof of the energy of this species

of attraction, than what has been already done in the chapter on chemical action; and the experiments subjoined at the end of this work; see experiments No. 43, 50, 52, 57, 58, 72, 84, 93, 103, &c. will be found amply sufficient for its general illustration.

The phenomena that arise from affinity of composition being founded on a number of facts, they are regarded by chemists as laws, which are as follows:

LAW 1.

Chemical affinity takes place only between heterogeneous particles, or particles of a dissimilar nature, as between metals and oxygen, acids and alkalies, &c.

ILLUSTRATIONS.

The union of muriatic acid and soda.

The union of nitric acid and copper.

The union of muriatic acid and mercury.

This law may also be illustrated by the experiments No. 54, 77, 80, 81, 135, 137, 155, &c. at the end.

LAW 2.

Chemical affinity requires the attraction of aggregation to be previously destroyed by some mechanical means, and the more minute the divi-

sions, with the more facility the combination takes place.

To this law there may be some few exceptions, but in all cases of chemical combination the union is facilitated by the substances being presented in the form of a disregate.

ILLUSTRATIONS.

Solution of camphor in alkohol.

Solution of resins in alkohol.

Solution of alum in water.

Solution of metals in acids, &c.

For the same reasons the different roots, barks, &c. used in pharmaceutical chemistry, are either sliced, bruised, or powdered, previous to being added to their respective menstrua.

LAW 3.

Chemical affinity cannot take place between two substances, unless one of them be in a state of fluidity.

This fact must have caught the observation of every one; salt cannot be united to ice, though most readily with water.

ILLUSTRATIONS.

Dry citric acid and carbonate of potash will not unite till water is applied.

In the formation of glass, heat is obliged to be

applied to bring one of the articles into a state of fluidity.

The union of mercury and sulphur requires the application of heat to bring one into a state of fluidity.

Sulphuret antimony and nitrate potash never would unite chemically until the cohesion of one was destroyed by the action of heat.

LAW 4.

Chemical affinity may take place between more bodies than two, and unite them into an homogeneous whole.

ILLUSTRATIONS.

Sulphuric acid, alumine, and soda, form the alum of commerce.

The fusible metal is a triple compound of eight parts, bismuth, five lead and three tin; this compound metal has the property of melting in boiling water.

Rochelle salt is composed of tartarious acid, potash, and soda.

Combinations of the volatile alkali.

According to Fourcroy, the number of compounds resulting from the various intermixture of about fifty indecomposable bodies, considered as being combined two and two, three and three,

four and four, &c. &c. will yield upwards of four millions and a half of compounds.

LAW 5.

A change of temperature always takes place the instant two or more bodies are forming a chemical union.

It is to be observed it is not always an increase but sometimes a diminution of temperature, that bodies experience in their action upon each other.

ILLUSTRATIONS.

The mixing sulphuric acid and water.

The solution of muriate ammonia in water.

The mixing alkohol and water.

The action of dilute sulphuric acid upon iron.

The solution of equal parts of nitrate potash and muriate ammonia in water.

LAW 6.

A new compound is produced by a chemical union, the properties of which are widely different from those that characterized the bodies when separate.

Proofs of this law are very numerous, as in law the first we observe a mild salt (common table salt) formed from the union of two caustic substances.

ILLUSTRATIONS.

Compounds formed		By the union of
Corrosive sublimate		Mercury and muriatic acid.
Vermilion . . .		Mercury and sulphur.
Red lead		Lead and oxygen.
Verdigris		Copper and acetous acid.
Sulphate iron . .		Iron and sulphuric acid.
Epsom salt . . .		Sulphuric acid and magnesia.
Glass		Potash and sand.

LAW 7.

The force of chemical attraction is estimated by the power required for the separation of their constituent parts.

A knowledge of this law is obtained by measuring the difficulty with which combinations are destroyed on the application of other substances, as a metal may be kept in solution by an acid, but is instantly precipitated on the addition of an alkali.

ILLUSTRATIONS.

A solution of	Iron in sulphuric acid	Is precipitated by	Solution of soda.
	Mercury in nitric acid		Muriatic acid.
	Lead in acetous acid		Sulphuric acid.
	Barytes in muriatic acid		Sulphuric acid.
	Magnesia in sulphuric acid . . .		Solution of potash.
	Silver in nitric acid		Muriatic acid.

LAW 8.

Different bodies have different degrees of attraction.

This law, like the preceding, has a reference to simple elective attraction; upon it the most striking and ingenious operations in chemistry are founded, it will be sufficiently exemplified by the following

ILLUSTRATIONS.

To a nitric solution of mercury add strips of copper, the mercury will be precipitated, and the copper dissolved; if to this iron be added, the copper will be precipitated, and the iron dissolved; if a piece of zinc be put into this, it will

precipitate the iron, and if ammonia be then added, it would precipitate the zinc, and the solution be a nitrate of ammonia; if to this we add lime water, the ammonia would be disengaged, and nitrate of lime would be left; and lastly, if we add to the nitrate of lime, some oxalic acid, the oxalate of lime would precipitate, and nitric acid would remain.

LAW 9.

The agency of chemical affinity is either limited or unlimited in certain bodies, in other words, chemical affinity is capable of uniting bodies in definite or in indefinite proportions.

Experience convinces us that there are bodies which are incapable of uniting beyond certain limits, termed a maximum; while others may be united in unlimited proportions.

ILLUSTRATIONS.

Water and alkohol may be mixed in unlimited proportions.

Sulphuric acid may be combined with any quantity of water.

Muriatic acid cannot take up more than a given quantity of soda.

Water cannot dissolve more than a certain quantity of salt.

Nitric acid cannot take up only a certain quantity of lime—when substances in this way cease to act any longer, or have taken up as much as they can hold in solution, they are said to be saturated.

Alcohol, therefore, cannot dissolve only a certain quantity of resin.

SIMPLE ELECTIVE AFFINITY.

THE most interesting part of Chemical science certainly consists in the doctrine of Affinities, or Elective Attraction—for on these attractions all operations and analytical processes in the examination of any substance depend, as well as all combinations and decompositions, whether natural or artificial.

Simple Elective Attraction is that in which one of two principles is displaced by a third. An instance of which is when sulphuric acid is added to a solution of barytes in nitric or muriatic acid —the barytic solution is instantly decomposed, the sulphuric acid unites with the barytes, and the nitric acid remains in the mother liquor, as is seen in the following illustration:

INST. 1.

$$\text{Nitrate of Barytes}\left\{\begin{array}{l}\text{Nitric Acid}\\ \\ \underbrace{\text{Barytes}\qquad\qquad}_{\text{Sulphate Barytes.}}\end{array}\right\}\text{Sulphuric Acid.}$$

In this diagram it will be seen, the solution used is nitrate barytes, placed without the bracket, its component parts are placed within; sulphuric acid is the precipitant employed; the new compound is precipitated, which the bracket pointing downward denotes.

INST. 2.

$$\begin{array}{c}\text{Nitrate}\\ \text{of}\\ \text{Silver}\end{array}\left\{\underbrace{\begin{array}{l}\text{Nitric Acid}\\ \\ \text{Silver}\end{array}}_{\text{Muriate Silver.}}\right\}\text{Muriatic Acid.}$$

INST. 3

$$\begin{array}{c}\text{Nitrate}\\ \text{of}\\ \text{Lead}\end{array}\left\{\underbrace{\begin{array}{l}\text{Nitric Acid}\\ \\ \text{Lead}\end{array}}_{\text{Sulphate Lead.}}\right\}\text{Sulphuric Acid.}$$

INST. 4.

$$\begin{array}{c}\text{Sulphate}\\ \text{of}\\ \text{Magnesia}\end{array}\left\{\underbrace{\begin{array}{l}\text{Sulphuric Acid}\\ \\ \text{Magnesia}\end{array}}_{\text{Magnesia.}}\right\}\text{Solut. Potash.}$$

INST. 5.

$$\begin{array}{c}\text{Sulphate}\\ \text{of}\\ \text{Iron}\end{array}\left\{\underbrace{\begin{array}{l}\text{Sulphuric Acid}\\ \\ \text{Iron}\end{array}}_{\text{Gallate Iron.}}\right\}\text{Gallic Acid.}$$

INST. 6.

Nitrate of Mercury	Nitric Acid	Copper.
	Mercury	

Mercury.

INST. 7.

Nitrate of Copper	Nitric Acid	Iron.
	Copper	

Copper.

INST. 8.

Nitrate of Iron	Nitric Acid	Zinc.
	Iron	

Iron.

INST. 9.

Nitrate of Zinc	Nitric Acid	Solut. Ammon.
	Zinc	

Zinc.

INST. 10.

Muriate of Lime	Muriatic Acid	Oxalic Acid.
	Lime	

Oxalate Lime.

INST. 11.

Nitrate of Lime.	Nitric Acid	Sulphuric Acid.
	Lime	

Sulphate Lime.

INST. 12.

Carbonate of Potash	Carbonic Acid	Tartareous Acid.
	Potash	

Supertartrite Potash.

DOUBLE ELECTIVE AFFINITY.

WHEN two bodies, each consisting of two principles, suffer decomposition by a reciprocal exchange and union of their elements, by which new compounds are formed, the exchange is said to be affected by Double Elective Affinity, as in the formation of carbonate of magnesia. Epsom salt, which is composed of sulphuric acid and magnesia, suffers a mutual exchange of its principles on being mixed with carbonate of potash—the consequence is, carbonate of magnesia precipitates, which the bracket pointing downward denotes, while the sulphate of potash remains in solution, which is known by the bracket pointing upwards, as may be seen by the following scheme:

INST. 1.

Sulphate Potash.

Sulphate of Magnesia	Sulphuric Acid	×	Carbonic Acid	Carbonate of Potash.
	Magnesia		Potash	

Carbonate Magnesia.

INST. 2.

Acetite Zinc.

Acetite of Lead	Acetous Acid	×	Sulphuric Acid	Sulphate of Zinc.
	Lead		Zinc	

Sulphate Lead.

INST. 3.

Sulphate Soda.

Sulphate of Iron	Sulphuric Acid	×	Carbonic Acid	Carbonate of Soda.
	Iron		Soda	

Carbonate Iron.

INST. 4.

Sulphate Potash.

Sulphate of Copper	Sulphuric Acid	×	Arsenic Acid	Arseniate of Potash.
	Copper		Potash	

Arseniate Copper.

INST. 5.

Nitrate Soda

Nitrate of Mercury	Nitric Acid	×	Muriatic Acid	Muriate of Soda.
	Mercury		Soda	

Muriate Mercury.

INST. 6.

Muriate Ammonia.

Oxalate of Ammonia	Oxalic Acid		Muriatic Acid	Muriate of Lime.
		×		
	Ammonia		Lime	

Oxalate Lime.

INST. 7.

Acetite Soda.

Sulphate of Soda	Sulphuric Acid		Acetous Acid	Acetite
		×		
	Soda		Barytes	Barytes.

Sulphate Barytes.

INST. 8.

Sulphate Ammonia.

Succinate of Ammonia	Succinic Acid		Sulphuric Acid	Sulphate of Iron.
		×		
	Ammonia		Iron	

Succinate Iron.

INST. 9.

Nitrate Soda.

Muriate of Soda	Muriatic Acid		Nitric Acid	Nitrate of Silver.
		×		
	Soda		Silver	

Muriate Silver.

THEORY OF COMBUSTION.

AS combustion is founded on principles of attraction, and acts a conspicuous part in a variety of chemical operations, we shall endeavour to give as clear a definition of its action as the arrangement and limits of this work will allow. Bodies are divided into combustibles, incombustibles, and supporters of combustion.

Sulphur, phosphorus, carbon, and the metals are of the first class. The earth's alkalies, &c. are of the second order. Atmospheric air, oxygen gas, nitrous gas, &c. belong to the class of supporters of combustion. Combustibles are bodies, which, in common language, are said to burn. Incombustibles are not immediately connected with combustion, as they are neither capable of burning themselves nor of supporting combustion. The supporters of combustion are incapable of undergoing combustion themselves, but are indispensably necessary to the process; for without the presence of one of them, no combustion can take place. In every case of com-

bustion, the supporter is consumed. The combustible body is decomposed; and light and caloric disengaged. The weight of the product, after combustion, equals the previous weight of the combustible and the supporter. The air wherein the combustion took place is rendered unfit for maintaining combustion, or supporting animal life. The combustible also, after combustion, becomes incombustible; but may be restored to its former state of combustibility, by absorbing from it on the principles of chemical affinity, its oxygen, which is the base of all the supporters of combustion, and which, during the process, is absorbed, fixed, and rendered more or less solid in the combustible body. Combustion may, therefore, be defined by the following corollaries: 1. Combustion cannot take place unless the temperature of the combustible be previously increased. 2. It is accompanied with a disengagement of light and heat. 3. During combustion, the nature of combustible bodies become altered, and their cohesion destroyed. 4. No combustion ensues without the presence of oxygen gas. 5. The air in which combustible bodies have been burnt, decreases in volume and weight, and the burnt body increases in weight precisely in the same ratio. 6. The air left after combustion is no longer fit for supporting it, or animal life. Combustion is, therefore, merely the play of

affinity between oxygen, caloric, and a combustible body. We also observe, during combustion, light as well as caloric is liberated; the former must therefore be derived from the combustible body. Indeed this supposition is strengthened by the difference in quantity, that different combustible bodies exhibit, during combustion. Thus, phosphorus, we see, emits a large quantity, sulphur a smaller, and carbon the smallest of the three. Therefore, if light be considered a substance, fire must naturally be a compound as well as most of our elementary substances; for light unquestionably constitutes a portion of them all. It has been supposed, that the light and heat both proceeded from the combustible body; but this is an erroneous idea, as also is the supposition of their both proceeding from the oxygen gas, not only for the reasons before stated, but also from their exhibiting different coloured flames during the process. Agreeably to this hypothesis, combustion may be explained by the laws of Double Elective Affinity. Take phosphorus for example, as composed of a certain base and light, introduce it into a vessel of oxygen gas—the consequence is, combustion takes place; phosphoric acid is formed, and light and caloric disengaged, as may be seen by the following scheme:

INST. 1.

Fire.

Phos-	Light		Caloric	Oxygen
		×		
phorus.	Unknown Base		Oxygen	Gas.

Phosphoric Acid.

INST. 2.

Fire.

Car-	Light		Caloric	Oxygen
		×		
bon.	Unknown Base		Oxygen	Gas.

Oxid of Carbon or Charcoal.

INST. 3.

Fire.

	Light		Caloric	Oxygen
Iron.		×		
	Base		Oxygen	Gas.

Oxid of Iron.

We have already stated, that the properties of bodies become altered, and their individuality destroyed by combustion. We shall now shew, that they may, by an opposite process, be brought to their combustible state, by the laws of

simple elective affinity; for example, take the phosphoric acid formed in the first instance, and expose it to a strong heat with carbon; (which has a greater affinity for oxygen than phosphorus has) the consequence is, the phosphorus is restored to its original state and an oxid of carbon is formed.

INST. 1.

Phosphorus.

Phosphoric	Phosphorus	
Acid.	Oxygen	Carbon

Oxid Carbon.

INST. 2.

Metallic Iron.

Oxid	Iron	
Iron.	Oxygen	Carbon

Oxid of Carbon.

Having thus given the general laws of chemical science and numerous instances of chemical attractions, illustrating these, we proceed next to the consideration of the portable chest, and the uses of the different articles it contains, as well as their application to the various subjects that fall under chemical investigation.

PORTABLE

CHEST OF CHEMISTRY.

THE chief preparations that compose a chemical chest, should be arranged to answer the views of particular professions or descriptions of persons; and the first step, previous to entering upon the different subjects of investigation that belong peculiarly to each class, is to form the *plan* of the chest, corresponding to these intentions.

The following is a description of the largest portable chest of chemical re-agents, &c. kept at the Chemical and Medical Hall, Piccadilly. On the top are partitions for forty-six stopper bottles of different sizes, with wide and narrow mouths, for the following articles. Each bottle, independent of a label, has a number engraved upon it, that in case the paper label should be destroyed, the contents of the bottle may be ascertained by the following numerical arrangement.

1. Black Oxid Manganese.
2. Metallic Zinc.
3. Metallic Nickel.
4. Carbonate Potash.
5. Sulphuric Acid.

6. Muriatic Acid.
7. Nitric Acid.
8. Carbonate Soda.
9. Carbonate Ammonia.
10. Muriate Lime.
11. Solut. Pure Potash.
12. Solut. Pure Ammonia.
13. Solution Sulphate Iron.
14. Prussiate Potash and Iron.
15. Tinct. Galls.
16. Solut. Mur. Tin.
17. Sulphuret Potass.
18. Solut. Acetite Lead.
19. Solut. Oxalate Ammonia.
20. Solut. Nitrate Lead.
21. Solution Sulphate Manganese.
22. Crys. Boracic Acid.
23. Solut. Nitrate Barytes.
24. Solut. Muriate Copper.
25. Sulphuric Ether.
26. Alkohol.
27. Oxalic Acid.
28. Metallic Bismuth.
29. Solut. Succinate Ammonia.
30. Phosphorus.
31. Oxymuriate Potash.
32. Oxymuriate Mercury.
33. Sulphuret Ammonia.
34. Solut. Nitrate Silver.
35. Phosphuret Lime.
36. Nitrate Copper.
37. Muriate Ammonia.
38. Citric Acid.
39. Solut. Nitrate Mercury.
40. Pure Strontia.
41. Pure Barytes.
42. Muriate Cobalt.
43. Acetic Acid.
44. Tinct. Soap.
45. Ammoniaret of Copper.
46. Solut. Mur. Gold.

In the drawer there are six stopper bottles for the following articles:

47. Black Flux.
48. White Flux.
49. Dried Borax.
50. Glacial Acid of Phosphorus.
51. Glass of Borax, &c. &c.

Four tin cases for

Turmeric Paper.
Litmus Paper.
Brazil Paper.
Gall Paper.

Also a drawer for scales and weights, graduated measure, funnel, knives, pestle and mortar, microscope, blow-pipe, and other apparatus for chemical experiments, with a copy of this work.

1. BLACK OXIDE OF MANGANESE.

Manganese, from its strong attraction for oxygen, has never been found in an insulated state. The black oxide is much employed in bleaching and in experimental chemistry, where it is chiefly used for furnishing oxygen gas, and in oxygenating muriatic acid. It is soluble in six parts of sulphuric acid, during which solution a considerable quantity of oxygen gas is disengaged. The residuum when dissolved and crystalized, forms the sulphate of manganese.

2. ZINC,

Is seldom found but in a state of combination. The native oxide of zinc is commonly called calamine, "lapis calaminaris." Zinc has a very strong attraction for oxygen, and therefore separates many of the metals from their solutions, and becomes a useful agent in analytical chemistry. From its property of decomposing water, it is much employed in furnishing hydrogen gas. It inflames in oxygenated muriatic acid gas, and fulminates by pressure with oxygenated muriate of potash, No. 31. It decomposes muriate ammonia, sulphate potash, and many neutral salts. Nitrate of potash and zinc detonates with rapidity. Its union with copper constitutes the article termed brass.

3. NICKEL.

This metal is generally found in its metallic state; when fresh broken it has a strong lustre and a fine grained compact texture; when fused with borax it produces a glass of a hyacinth colour. It is acted on by the sulphuric, No. 5, and muriatic acid, No. 6. The nitric acid, No. 7, is rapidly decomposed by it, forming a beautiful green solution. It may be readily oxidated by the nitrate and oxygenated muriate potash. With ammonia, No. 12, it forms a blue solution, which is rendered green by the addition of nitric acid, No. 7.

4. CARBONATE OF POTASH.

There exists a strong analogy between this salt and carbonate soda. It precipitates all metallic substances from their acid solutions in the state of carbonates. It is also much employed in the making effervescent draughts, &c. Carbonate of potash, when added to tartareous acid, forms a salt of difficult solubility, which is cream of tartar, or supertartrite potash. Whereas the tartareous acid united with soda forms a salt very soluble. This property furnishes a ready method for distinguishing these two salts.

5. SULPHURIC ACID.

As we shall have occasion to notice this acid hereafter, we shall confine our attention here more to its application as a test. It separates barytes from all its combinations, forming with it an insoluble precipitate; it also separates lead and silver from their solutions, forming insoluble compounds; with nitrous acid it forms a compound that dissolves silver, but scarcely any other metal. It forms with lime the well known article termed gypsum or plaster Paris, and when combined with soda it produces the aperient known by the name of Glauber's salt. It oxidates and dissolves most of the metals, and is much employed in the arts, chemistry, and pharmacy.

6. MURIATIC ACID

Has a strong affinity for silver, copper, mer-

cury, &c. It disengages phosphoric, sulphuric, and carbonic acids from all their combinations. With soda it constitutes our common table salt, and with other bases forms articles much used in medicine and pharmacy.

7. NITRIC ACID.

This acid is a compound of nitrogen and oxygen, and is so slightly united to its base as to be decomposed by almost all the metallic substances to which it is submitted. This is exemplified in the solutions made with mercury, iron, silver, tin, bismuth, copper, &c. during which solution a prodigious quantity of nitrous gas is disengaged. Sugar easily decomposes it, and converts it into the oxalic acid. Nitric acid when mixed with about an equal quantity of the muriatic acid, forms the aqua regia, a solvent for gold, and has the properties of the oxymuriatic acid, by its imparting oxygen to the muriatic acid, and thereby rendering it in a manner oxygenated. This acid tinges the skin a permanent yellow: It inflames oil, charcoal, &c. when poured on them in a concentrated state. It converts the sulphureous and phosphorous acids into the sulphuric and phosphoric acids, by yield-ing to them part of its oxygen.

8. CARBONATE OF SODA,

Like carbonate potash, is a test for all acid solu-

tions of metallic substances which are precipitated by it in the state of carbonates. Thus to a solution of sulphate of iron, if carbonate of soda be added, an instance of double elective attraction ensues. Carbonate of iron is precipitated, and sulphate of soda remains in solution. The same takes place with all other metals.

9. CARBONATE OF AMMONIA

Is the test of all earths contained in any liquid Also of uncombined muriatic acid. It likewise detects copper in all its combinations, by forming with it a deep blue substance, the ammoniaret of copper.

10. MURIATE LIME.

Like muriate soda, and the other muriates when acted upon by sulphuric acid, No. 5, yields muriatic acid, and when acted on by the nitric acid, No. 7, gives out the oxygenized muriatic acid. Though muriates of all salts are the most volatile, yet they are the least indecomposable by heat, which is a striking characteristic of this species of salt. A concentrated solution of muriate lime with a solution of Potash, No. 11, produces a solid compound.

12. PURE AMMONIA.

This substance precipitates all the earths, like-

wise iron, and several of the metals, in their metallic state. Hence it is the best means of separating iron from its menstrua. Copper dissolved in any liquid it also detects, by communicating to it a blue colour.

13. SULPHATE OF IRON.

This test is particularly applied to detect the astringent principle, gallic acid, &c. It is strongly instanced in the making of ink, black dyes, &c. the iron uniting with the gallic acid forms the gallate of iron. It is also employed for detecting the presence of oxygen, which converts it into a super sulphate.

14. PRUSSIATE OF POTASH AND IRON.

Any liquid containing iron dissolved by carbonic or any other acid, will part with it in the form of a blue precipitate, by adding a few drops of the prussiate of potass of iron. In case of carbonic acid, if the liquor be heated, by discharging the acid, a precipitate of an ochre colour will fall to the bottom. On the addition of more of this preparation no blue colour will ensue, unless there is also the presence of another acid dissolving the iron. All metals indeed held in solution will be precipitated by this substance of different colours.

15. TINCTURE OF GALLS.

This is the best test for discovering iron, with all the combinations of which it produces a black tinge, more or less intense, according to the proportion of iron. If the black tinge it produces takes place after as well as before boiling in water, the acid may be pronounced of the mineral kind; but if only before, and not after, the acid may be considered the carbonic.

16. MURIATE TIN,

Has a great affinity for oxygen; it de-oxidizes a solution of indigo in an instant, and changes it from blue to green. It is much employed in dying to give a brightness to cochineal, Brazil wood, &c. and to precipitate the colouring matter of many dyes. Carmine, lake, &c. owe their brightness to this peculiar salt.

17. SULPHURET OF POTASH

Is a test for detecting the presence of many metals in any liquid, as lead, silver, bismuth, mercury, &c. It forms the base of Hahnemann's wine test, which indicates the presence of lead by a dark coloured precipitate.

18. ACETITE OF LEAD.

This preparation discovers the presence of the

sulphuric and muriatic acids, as well as any of the neutral salts they form, by its producing on its addition to the liquid a white precipitate, which in the case of the muriatic acid, is soluble in the acetous or vinegar, but in case of the sulphuric it is not. To prevent any action of the carbonic acid it should be first expelled by a few drops of nitrous acid previously employed, and then the above experiment made. A liquid containing hydrogen gas presents throughout this test a dark coloured precipitate.

19. OXALATE AMMONIA.

This test is applied for the discovery of lime, either by itself, or in combination with the carbonic acid. It renders the mixture of lime turbid by forming an oxalate of lime, which will be precipitated. When the proportion of earthy matter is small, the turbid appearance of the fluid will not ensue, till it has stood a few hours. The same appearance takes place when magnesia is present.

20. NITRATE LEAD.

This test is superior to the acetite of lead for chemical purposes, as the latter is more liable to give false results. It indicates the presence of sulphuric acid, however minute the proportion may be. It

decomposes all the alkaline sulphates, and detects the presence of sulphuretted hydrogen, and hydro sulphurets of alkalies.

21. SULPHATE MANGANESE.

This salt is the residuum after obtaining oxygen gas by decomposing sulphuric acid with black oxide manganese. It is but little used as a test; but is not unfrequently employed by the experimentalist. A solution of sulphuret of potash, No. 17, in alkohol, No. 26, has the property of reducing it to its metallic state. Vide Exper. No. 177.

22. BORACIC ACID, OR ACID OF BORAX.

It is soluble in alcohol, to the flame of which it gives a green colour, surrounded with white. When heated strongly, it fuses into glass, and is volatilized by boiling in water. It has no action on combustible bodies. It is sometimes found in mineral waters, in which it may be discovered by the nitrate and acetite of lead. When united with soda it forms the salt known in commerce by the name of borax.

23. NITRATE OF BARYTES.

By this test the presence of sulphuric acid in any state is detected, for the acid immediately unites with the barytes and forms with it an

insoluble precipitate of sulphate of barytes. The liquid should stand a little, in order to wait for the separation.

24. MURIATE COPPER.

A solution of this Salt is generally employed as a sympathetic Ink. A letter, wrote with this preparation, is invisible in the cold, but becomes a most beautiful yellow on being held to the fire, which disappears and re-appears at pleasure. With a calcareous base, it forms the color known in commerce by the name of Mineral Green.

25. SULPHURIC ETHER.

This fluid is extremely light and inflammable. It is very diffusible in air, and during its evaporation produces an intense degree of cold. It burns readily on the surface of water. When highly rectified it becomes the only solvent of caoutchouc, or elastic gum. It burns vividly in oxygen gas. With phosphorus dissolved in it, it forms the article called phosphuretted ether, which causes the hands or any part of the body to appear luminous in the dark.

26. ALCOHOL.

By this fluid are separated all the neutral salts formed with the sulphuric acid when suspended in any liquid, and it should be in equal parts with

the latter. In a larger proportion it operates in a similar manner to alkaline salts formed by the nitric and muriatic acids, but not the metallic or earthy solutions with these acids. Resinous and oily substances are also separated by the same means. It also precipitates mucilaginous matter.

27. OXALIC ACID.

This acid is obtained by the acidification of sugar; hence it is not unfrequently termed the Saccharine Acid. It has for lime a greater affinity than any known substance. It separates it from all its combinations. This acid has also a singular affinity for Oxid of Iron, and is, on this account, much employed for removing ink stains, iron moulds, &c. When united to Soda, it forms the salt known in common by the name of Salt of Sorrell; with Supertartrite Potash, it forms the salt sold under the title of Salt of Lemon.

28. BISMUTH.

This metal is of a white silvery appearance, but soon becomes tarnished. It dissolves in the Sulphuric Acid, No. 5, and also in the Muriatic Acid, No. 6. Its solution in the Nitric Acid is decomposed by mere dilution with water which precipitates a White Oxide, generally termed Majestery

Bismuth. It inflames in Oxygenated Muriatic Acid Gas, and unites with most of the metals, increasing remarkably their fusibility.

29. SUCCINATE OF AMMONIA

Is much used for the discovery and separation of iron, with which it produces a brownish precipitate. The succinates have been also much employed for the separation of alumine where there is no considerable excess of acid. On magnesia it has no action; hence it may be successfully employed in the separation of these two salts.

30. PHOSPHORUS.

The chief use of this singular substance is for experimental purposes. In this part of the science, phosphorus ranks paramount to every other for the multiplicity and beauty of the experiments that may be exhibited with it. There is one objection to this substance, the extreme danger in using it. It has so great an attraction for Oxygen, as to take fire spontaneously at a very low temperature, when exposed to the atmosphere. It is, therefore, necessary constantly to be kept under water. Alkohol Ether, Expressed and Essential Oils, dissolve it, forming with it highly inflammable compounds. In using this substance, too much care cannot be taken, and in the experi-

ments subjoined to this work, the quantity mentioned ought never to be exceeded.

31. OXYMURIATE OF POTASH.

This is a salt not much employed as a test, though much used by the experimentalist. Three parts of this salt and one of sulphur, mixed in a mortar, detonates loudly; the same effect is produced when struck with a hammer upon an anvil. With phosphorus it detonates with a prodigious force. It may be inflamed by the addition of nitric or sulphuric acid. When combined with sugar it inflames by coming in contact with sulphuric acid. On this principle is founded the new invented instantaneous lights.

32. OXYMURIATE MERCURY.

This is one of the most powerful preparations of mercury, and when taken internally to the extent of a few grains, generally proves fatal. It is not much employed as a test, but enters into many of the experiments subjoined at the end of this work. Its action upon the animal system is best counteracted by Alkaline Sulphurets.

33. SULPHURET OF AMMONIA,

Sometimes called hepatised ammonia, is the most sensible test of lead, arsenic, antimony,

&c. With lead it forms a black precipitate; with arsenic a yellow; and with antimony a deep orange, called Kermes's mineral.

34. NITRATE OF SILVER.

A discovery is readily made by this preparation of the presence of the sulphuric or muriatic acids. Thus, on the addition of a few drops of this preparation to any liquid containing sulphuric acid, there will be formed a white crystalline powder, soluble in 900 parts of water. When it contains the muriatic acid, it will shew a white flaky precipitate, which turns black on exposure to light. Where a liquid contains hydrogen, or any of its preparations a black precipitate will descend on the addition of the nitrate; the same dark precipitate will attend the action of extractive matter. Mucilaginous matter in any liquid is also detected by the same test, for a few drops of this solution afford a precipitate, three grains of which contain two of mucilage.

35. PHOSPHURET LIME.

This is never applied to any other than experimental purposes. It has the singular property, when moistened with water, of generating phosphorated Hydrogen Gas. This Gas takes fire on coming into contact with Atmospheric Air,

accompanied with an extreme fœtid odour. See a number of experiments with it, subjoined at the end of this work.

36. NITRATE OF COPPER,

Is a test for the presence of ammonia, which immediately turns of a deep blue colour on the application of this substance. It has also, when moistened with water, the singular property of inflaming tin, which is shewn by placing a little of the powder of the nitrate upon a piece of tinfoil about two inches square, and adding to it a single drop of water, by being folded up quickly, and then enveloped in a piece of brown paper, combustion speedily ensues, and the tin inflames.

37. MURIATE AMMONIA.

This test is applied to the same purpose as Muriatic Acid, and the other Muriates, for the separation of Silver, &c. It also enters into the composition of frigorific mixtures, as it, during its solution in water, produces 32 degrees of cold.

38. CITRIC ACID.

This acid, on account of its solubility, is extremely useful to our manufacturers. Within these few years, an important use has been made of it in

medicine. It is said that the largest dose of opium may be checked in its narcotic effects, if a sufficient quantity of Citric Acid be taken with it, producing cheerfulness instead of stupefaction, succeeded by refreshing sleep. It is also useful for many domestic purposes. As this acid can be kept in powder, mixed with Carbonate Potash, No. 4, it becomes a ready method of making the Saline Draught.

39. NITRATE OF MERCURY.

This is a test of the muriatic and sulphuric acids, in the same manner as the nitrate of silver, with each of which substances it forms precipitates nearly insoluble in water. This solution, when evaporated to dryness, and exposed to a strong heat, in contact with atmospheric air, forms the red oxid of mercury, or red precipitate.

40. STRONTIA.

There is a similar analogy between this substance and barytes, as there is between potash and soda. It changes the colour of blue vegetables green, and renders oil, like alkalies, miscible with water. Like them also it attracts carbonic acid from the atmosphere. It changes the colour of inflammable bodies, or rather co-

lours the flames of such bodies while burning, of a beautiful red. It has been employed in medicine to correct acidity, where magnesia proves too aperient.

41. BARYTES.

This substance imparts to the flame of burning alkohol a beautiful yellow colour, and is much employed in the analysis of mineral waters, &c.

42. MURIATE COBALT.

This preparation is generally used as a Sympathetic Ink. Writing, with this solution, is invisible till held to the fire, when it appears of a beautiful green. A landscape, drawn with Indian ink, and the foliage with Muriate of Cobalt, has a very pretty effect. When cold, it will appear merely an outline of a landscape; but, on being held to the fire, the trees, &c. will display their natural colors. If an Alkali, as the Carbonate Potas, No. 4, be added to Muriate Cobalt, an Oxide is precipitated soluble in Acetous Acid, forming an Acetite of Cobalt, which makes a beautiful Blue Sympathetic Ink. *See Experiments at the end.*

43. ACETOUS ACID.

This applies particularly to the detection of ammonia or volatile alkali in any liquid. The outside of a glass is to be moistened with the acid, and suspended on the surface of the liquid, by which means there will arise fumes on the surface of the glass, which denote the presence of ammonia. A similar phenomenon takes place when weak nitrous acid is used.

44. TINCTURE OF SOAP.

This serves, by its decomposition in the form of a flaky precipitate, to detect the presence of carbonic and other acids, as well as of earthy and metallic salts contained in any liquid. This detection proceeds on the principle of double elective attraction, and is shewn in the attempt to wash clothes with hard water.

45. AMMONIARET OF COPPER.

This is an excellent test for the discovery of arsenic in any liquor, for it produces with it a yellowish green precipitate, which separated, dried, and thrown on the fire, gives out the peculiar garlic smell of arsenic. The precipitate is only soluble in pure ammonia and in acids. This precipitate has received the name of Scheele's Green.

46. NITRO MURIATE OF GOLD.

This article has the property of tinging the skin of an indelible purple colour, and produces the same effect on all animal and vegetable bodies, and even upon marble. If we immerse a sheet of tin in this solution, a beautiful purple precipitate descends, known by the name of the purple powder of Cassius and much used in enamelling. Solutions of gold are decomposed by hydrogen or sulphureous acid gas. See Experiments at the end; also *Mrs. Fulham's Essay on Combustion.*

11. POTASH, OR PURE VEGETABLE ALKALI.

By this article all metals are separated from their acid solutions in the state of metallic oxids. It also indicates the presence of magnesia in any liquid by the formation of a white precipitate, which, when dried, shews itself by its specific gravity.

OXYMURIATIC ACID.

This acid has been omitted in the chest as it may be readily prepared, and sufficiently pure for most purposes, by dissolving oxymuriate potash, No. 31, in muriatic acid, No. 6, and diluting it with water. It is muriatic acid holding an excess of oxygen. It has the singular property of discharging all vegetable colours to which it is applied.

On this account it is much used in bleaching, and forms the base of most of the bleaching liquids that are sold. It thickens oil and animal fat, and renders them less disposed to combine with alkalies. For the purpose of bleaching, this article is best applied in a gaseous form, which may be done by pouring a little muriatic acid upon black oxide of manganese in a teacup, and holding the article to be bleached over the fume that arises from the mixture. In this manner stains of red port wine, fruit, tea, &c. may be easily discharged. Its union with alkalies forms salts possessed of singular properties, to be afterwards noticed.

BARYTIC WATER.

This test may be extemporaneously made, by dissolving pure barytes to saturation in distilled water. It is much employed as a test for sulphuric and carbonic acids, with which it forms insoluble precipitates. The latter is known by the name of terra ponderosa or ponderous spar.

LIME WATER

Is prepared by taking a few ounces of quick lime, and pouring upon it about two pints of water, in a covered vessel. Lime water mixed with other water, indicates the presence of the carbonic acid, if it contain any, by becoming im-

mediately turbid. Lime water detects also the presence of oxymuriate of mercury in any liquid by the yellow or brick dust precipitate it forms, which will be more complete if the lime water be added to the liquid boiling hot. A solution of mercury in nitrous acid is detected by the same means; and also of arsenic suspended in any liquid which yields a precipitate of difficult solution in water, requiring for each part 1100 parts of cold water.—Copper, in any liquid, is precipitated by lime water of a green color; and antimony, especially the tartarized, falls down of a white color.

Lime water is a delicate test, and apt to become turbid, by opening the glass and exposing it to the air. It therefore ought always to be used when fresh prepared.

TINCTURE OF LITMUS.

As this tincture is easily made by tying in a rag a little turnsole and boiling it in water, it has not been admitted into the chest. It is the test of all acids, the blue color of the tincture being changed by them from blue to red; if the acid be carbonic, the mixture on being heated will become blue again by the disengagement of the acid; but if the change be produced by

any of the more fixed acids, the color remains permanent.

LITMUS PAPER.

This is preferable to the infusion as a test for acids, for it suffers no change from exposure to the atmosphere.

BRAZIL PAPER.

The change of color with this paper from red to violet, indicates the presence of an alkali, and in order to its successful application the solution in which it is to be tried should be evaporated a little, to expel any carbonic acid. When of a violet color, on the application of an acid its red color will be restored, which shews it also a test for acids.

TURMERIC PAPER AND INFUSION.

This is reckoned the best test for the presence of an alkali, as undergoing no alteration from the presence of any earthy bodies that may be in the solution. The action of an alkali changes them from yellow to a brown color, and the action of an acid changes them from brown to yellow. They therefore become a test for both.

OF LIGHT.

Light and Caloric are considered by many as comparative terms; but it is the opinion of Dr. Herschel, as well as many of our first philosophers, that they are distinct and separate substances—resuming this latter hypothesis, which certainly better deserves the name of Theory, we will endeavour to give the student as definite an idea of its nature and action as the subject will admit. Considering it then in this point of view, we must consequently regard it as possessed of gravity—however, the real nature of light is to this day but partially understood. Some consider it as merely a modification of Caloric, or Elementary Fire; some regard it as an effect, while others as a mere cause: but the most prevalent opinion is, that it is a peculiar and distinct substance, universally diffused throughout nature. Light is obtained from a variety of sources, as the sun, fixed stars, and other luminous bodies, combustion, &c. Solar light by the prism, is divided into seven different coloured rays, refrangible in the following order: red, orange, yellow, green, blue, indigo, and violet—the red being the least, and the violet the most refrangible. Light is more or less absorbed by most bodies, but they do not absorb the different colored rays indiscriminately, but different bodies absorb different

rays, and reflect the rest. Brugnatelli thinks, that light is either chemically united with bodies, and in that case separates itself from them, in consequence of its affinity for caloric; or that it is merely accumulated in bodies, and rendered free by an approximation of their parts. The former supposition is somewhat corroborated in the formation of fire during combustion, which the ingenious Dr. G. Pearson describes as consisting of Light and Caloric; though he does not consider them as distinct species of matter. See also Combustion, p. 33. Light is unquestionably possessed of numerous chemical affinities; in short, there scarcely exists any substance which does not experience some change from its presence or absence. So great is its affinity for oxygen, that metallic oxides are reduced by it, acids are decomposed by it, and oxygenated muriatic salts are brought to the state of muriates. The color, odour, taste, combustibility, and resinous principle of vegetables, are thought to be owing to it. So sensible are gardeners of the influence of light upon vegetables, that lettuces, &c. they either bind them round, earth them up, or by some other means deprive them from the action of light. Wood exhibiting under its bark a whiter aspect, arises from the same cause. The durability and beauty of those coloring drugs which are extracted from certain vegetables in the

oriental countries, are supposed to be owing to their greater exposure to the influence of the solar rays in those parts. Professor Davy assures us, that red rose trees made to grow in the dark, produce roses nearly white. Another singular property of light upon vegetables is, its causing them to pour into the atmosphere torrents of vital or pure air in the day-time, while in the night they generate a very deleterious gas.

There are also substances that have the power of absorbing light, and emitting it again months after, without the aid of any sensible heat; such bodies are termed *Solar Phosphori*. Of this class are Canton's, Baldwin's, Homberg's, and the Bolognian phosphorus. These substances, as before stated, have the power of absorbing the rays of light, and disengaging them in the dark, without any elevation of temperature. The eyes of cats, owls, and many other animals, are so constructed as to collect light, and thereby enable them to find their food in the dark. From what has been advanced, light certainly appears to possess affinities peculiar to itself, and its universal agency in the operations of nature, is apparently great, distinct, and certain; it seems destined for the benefit of the whole universe, and consequently travels over all. It produces upon the animal creation the sensation termed vision, which thereby informs us of the presence of objects we are

not near enough to touch; empowers us to distinguish bodies into transparent, opaque, and coloured; and enables us to behold with admiration the beauty and harmony of the universe, and contemplate its divine original.

OF CALORIC.

In chemical language, Caloric is a metaphor used to denote that property of matter which produces the sensation we term heat;—that is, Caloric is used to express the cause, while the term heat is applied to the sensation itself. We will not attempt to decide upon the various opinions that have been given respecting this peculiar principle, but briefly notice its nature and action, as a different and distinct substance. Caloric is analogous to light in its vast velocity, being unconfinable and imponderable. It appears to possess wonderful elasticity, and is consequently the universal cause of fluidity; but so great is its subtility, that neither has its gravity been appreciated, nor its separate existence distinctly shewn. We have already pointed out, under the head of Repulsion, that it is in constant opposition to the attraction of cohesion. When the latter power prevails, bodies are solid; when caloric predominates, they assume a liquid or an aeriform state; but the moment this ceases to act, attraction immediately begins. This is owing, in some degree, to its con-

stantly tending to an equilibrium. This property of caloric is sufficiently obvious, when we are surrounded by an atmosphere colder than the natural heat of our bodies, we experience the sensation of coldness, by being deprived of part of our caloric by the surrounding medium. But this sensation ceases, as soon as both are at a mean temperature. The same effect ensues, when we are surrounded by warmer air; in this case, it is our bodies deprive the circumambient fluid of a portion of its heat; the common temperature, thus acquired, will be in an exact arithmetical ratio between the two original temperatures; that is, the one loses precisely what the other gains.

The principal sources of heat are the sun's rays, combustion, chemical action, friction, electricity, and galvanism. All bodies contain two portions of caloric; the one is termed sensible heat, the other latent heat.

Sensible Heat, or Free Caloric, comprehends all heat that is perceptible to the senses, or can be indicated by the thermometer. The most remarkable property of this species of caloric is its power of dilatation. This scarcely needs illustration; a ring that exactly fits an iron bolt when cold, cannot be got in if the iron be heated to redness. On this account, iron hoops are put upon casks, &c. hot, that they may hold faster when cold. A bladder, apparently empty, if laid before a

fire, with its neck closely tied, will gradually be dilated; if the heat be continued, will burst the bladder, from the expansion of the internal air; but the most striking instance of expansion is in the thermometer. A tube, containing alkohol, will be seen, by grasping it with a warm hand, to ascend; by the same rule, a common stove fire is ever striving to bring the surrounding bodies to its own temperature. Caloric seems to have a species of affinity for different bodies: thus it passes through metals, or marble, with much more facility than through wood; a simple instance of which is, a purse held to a fire, containing money—the purse will feel scarcely warm, but the money becomes too hot for the hand to bear it. If a rod of iron, porcelain, and wood, of equal dimensions, are put into a fire, the end of each will be found to have conveyed the heat very differently; the iron will be very hot, while the wood will be scarcely warm. The iron is therefore considered a good conductor of heat. The sense of feeling discovers to us whether bodies are good or bad conductors. The more dense bodies are, the better it appears they conduct heat; on this account flannel, from its being a bad conductor, is worn next the skin, which in winter keeps us warm, and in summer cool. The plumage and feathers of birds, the fur, wool, hair, &c. of animals, are such bad conductors of heat, that they were assigned

by Divine Providence to guard them against the inclemency of the weather.

Latent Heat was first discovered by Dr. Black, who, from a number of experiments, has proved that all bodies contain a portion of caloric imperceptible to the senses, and not to be indicated by the thermometer. It is, as it were, laid up in bodies till we have occasion for it, but whenever it quits its latent state it returns to free caloric, as in the hammering of metals. Iron, for instance, by this means may be made red hot. It is supposed to be chemically united in bodies, and to be essential to their existence. Dr. Black has proved, that whenever caloric combines with a solid body, the body becomes heated only until it is rendered fluid, viz. when it has acquired the fluid state, its temperature remains stationary though caloric is continued to be added to it. From this fact, the laws of latent heat have been inferred; it is illustrated by placing some snow, or ice, that have been reduced to several degrees below the freezing point, over a lamp, or in a warm room, the thermometer will be observed to rise gradually till it has reached the freezing point; but there it stops, the ice or snow now begins to melt, and though it is surrounded by warm air, the process goes on but very slowly, and its temperature remaining the same at 32 degrees; but as soon as they are arrived at their state of liquidity, the

thermometer instantly begins to rise; and if the heat be continued, it will continue to rise till it has got to the boiling point, where it will again become stationary. So it is evident in the melting of the snow, or the ice, that the caloric became latent in the new formed liquid, because the heat could no longer affect the thermometer after it had raised it to the freezing point, but was wholly employed in the conversion into water; after which the caloric was no longer latent, but became free and indicatible by the thermometer; when the water boiled the thermometer again stopped, the liquid was evaporated, and the latent heat became insensible in the vaporized portion. Solids are therefore converted into liquids, and liquids into vapour, or gas, by a certain quantity of caloric uniting with it, and it has been shewn that the fluidity of melted wax, metals, resin, fat, &c. &c. proceed from the same cause. Hence we may infer, that whenever a body changes its state, it either combines with, or is separated from, caloric. By a body changing its state, is meant its transition from a solid to a liquid, or from liquidity to aeriform fluidity. On this transition of substances is founded the art of producing artificial cold, or frigorific mixtures, which have the property of reducing the temperature of the thermometer at pleasure. Mixtures of this kind, are for instance, equal parts of nitrate of potash, and

muriate of ammonia, dissolved in double their weight of water, which will sink a thermometer from 50 to 10 degrees; three parts of muriate of lime, and two parts of snow, produce a degree of cold competent to sink the thermometer from 32 to 50 degrees.

We have seen that latent heat is solely employed in effecting a change of state in bodies, it must also follow, that liquids contain more of it than solids, and aeriform fluids more than liquids. From this theory of latent heat, the whole of the phenomena, as well as the evolution of heat during putrefaction and fermentation, are readily explained.

Free caloric we consider as constantly moving through the most minute particles of bodies; latent heat, as lodging between these particles; and chemical heat,* forming a true chemical union, in consequence of its affinity with the constituent particles of bodies; its union is so complete, as not to be annihilated by any mechanical means, but it may, like other substances, be produced by superior attraction.

From what has been already stated, there can be little doubt of caloric being a distinct species of matter. The experiments of Dr. Herschel in

* Chemical heat, or caloric, in combination, is that species of heat which is considered as forming a constituent part of all bodies.

some degree confirm it; he having apparently separated light from heat in the solar beams.

OF OXYGEN.

From the strong tendency this substance has to combination, we have never been able to obtain it in an insulated state;—its existence is, nevertheless, certain, from the number of combinations and decompositions that are affected by it. In the laboratory of nature, its agency is almost universal; it is absorbed during combustion, and in the calcination of metals. It is absolutely necessary for the formation of acids, it being their acidifying principle; it is also indispensably necessary to respiration; consequently forms a part of atmospheric air. It likewise enters into the composition of water, and forms an essential part of the multifarious bodies of the animal and vegetable kingdoms. The simplest form it has ever yet been obtained in, is in combination with caloric, in the state of oxygen gas,* which was called by Dr. Priestly, who discovered its dephlogisticated air, and from its being necessary to respiration and combustion, it has been termed vital air, empyreal air, pure air, &c. It is void of color, taste, and smell; it is capable of being respired three times as long as common air. Combustion is rendered beautifully splendid, and much accelerated by it, which is shewn in a number of the experi-

ments subjoined at the end of this work. It constitutes 28 parts in every 100 of atmospheric air, and 85 parts of every 100 of water. Combustion and oxygenation are effected by the absorption of oxygen, and all bodies by this absorption become either acids or oxides. Acids are known by a sour taste, by changing vegetable blues, red, and by the power of uniting with alkalies, by which the properties of both are altered. Acids unite also with a number of other substances, forming a class of peculiar substances, termed salts; the general characters of these are sapidity, ready solubility in water, and incombustibility.

Oxides.—The term oxide is used to denote that combination of oxygen where no acidity exists; some are acidifiable, others are not; among the latter are water, and many of the metallic oxides; they are, for the most part, insoluble in water, and destitute of taste and smell. Mrs. Fulham is of opinion, that oxidizement proceeds from the decomposition of water, and which she substantiates by a number of ingenious and interesting experiments.* Though this hypothesis is not totally denied, the theory of Lavoisier is more generally received. The blood in the lungs absorbs during respiration oxygen gas, thereby it acquires an augmentation of its vital powers, and becomes of a vermilion color.

* See Mrs. Fulham's Essay on Combustion.

OF NITROGEN.

Nitrogen, or Azote, is that principle that remains after the calcination of combustible bodies, in a given quantity of atmospheric air; it is the radical or the acidifiable base of the nitric acid, and a component part of ammonia. Like oxygen, it has never been found in an insulated state; it forms the major part of atmospheric air, and is a constituent part of animal and vegetable substances. It probably enters into the formation of alkalies. In short, it is considered by some as a real alkaligen, or alkalising principle, in opposition to oxygen, the acidifying principle. The simplest state in which we can obtain nitrogen is in its combination with caloric, as nitrogen gas, for the discovery of which we are indebted to Dr. Rutherford; and from its fatality to animal life, it received the name of Atmospheric Mephitis. This gas seems to possess exact opposite properties to oxygen, that is, it is incapable of supporting either respiration or combustion. It exists in atmospheric air in the proportion of 75 to 100; with oxygen in different proportions it forms compounds of very different properties, as the gaseous oxide of nitrogen, nitrous gas, nitrous acid, nitric acid, &c. In nitrogen gas no combustion can take place, nor animal exist; but this effect does not appear to arise from any deleterious property in the nitrogen, but from the want of oxygen.

OF ATMOSPHERIC AIR, AND ATMOSPHERICAL PHENOMENA.

The atmosphere is the grand receptacle of all volatilized productions of terrestrial bodies; in it nature operates immense analyses and combinations, and though not perceptible to our eyes, manifests itself in a multiplicity of ways. We are plunged into it the moment we are born, in it we exist, and were we ever to be deprived of it, we must, like fish, when removed from their element, unavoidably perish. Atmospheric air, which we distinguish from the atmosphere itself, appears to be a triple combination of oxygen, nitrogen, and carbon, rendered aerial by the expansion of caloric, varying very little in its proportions wherever we examine it, of 24 oxygen, 75 nitrogen, and 1 of carbonic acid. The proportion of oxygen seems comparatively small, when we consider the immense quantity continually consuming in the two great operations, combustion and respiration. But what consummate wisdom is manifested by the great Artificer, in enabling the vegetable kingdom to furnish sufficient for this great consumption, which in all probability unites with the nitrogen rejected by the animal respiration, and is thus perpetually forming new portions of atmospheric air. Hydrogen and carbon also being the necessary food of plants,

are absorbed by them, which otherwise by their accumulation in the atmosphere would be prejudicial to animal life; and they themselves disengaging vital air, keep the atmosphere in a regular state of purity. The carbonic acid in atmospheric air, though only one per cent. serves many valuable purposes; without it none of our buildings would acquire their necessary firmness, as it is well known mortar hardens in consequence of the absorption of this gas; and it is much to be doubted, whether plants would vegetate as they now do, were they deprived of it. Thus, what is noxious to man is beneficial to vegetables. How wisely has the Creator contrived to keep his creatures from the baneful effects of that immense quantity with which the atmosphere must constantly be contaminated. The physical properties of the atmosphere are no less worthy observation. Its fluidity renders it susceptible of those frequent and rapid motions of its parts, we term winds. Its gravity also is of the greatest importance in the economy of nature, for upon it depends the ascent of water in pumps, syphons, &c. The weight of the atmosphere is also an obstacle to evaporation, by which means water is kept in a state of liquidity. The gravity of air has likewise given rise to the invention of the most useful engines and machines used in all kinds of water-works; by it water is forced into pipes, and conveyed into any suitable

place; on it also depends the changes seen in the barometer. The action of the lungs is maintained by its pressure; it therefore is absolutely necessary to life. Water also exists in the atmosphere, and under certain circumstances in immense quantity, in consequence of the evaporation from sea and land; these exhalations being of less gravity, ascend to a certain height, where they coalesce and thicken; their particles then obstructing the rays of the sun, form what are termed *clouds;* when these vapours are taken up during the heat of the day, they generally after sun-set, in the cool of the evening, lose a part of their caloric, and become partially condensed, forming *mists* and *fogs* in low grounds, *dew in summer*, and *hoar-frost in winter*. When various congeries of clouds are driven together by the wind, they mix, and by losing a portion of caloric, which kept them in solution, they gain their original state of liquidity, which falls from its gravity to the earth; but by the resistance of the air, it is divided and subdivided into millions of parts, which, when arrived to us, is called *rain*. As the air must unavoidably derive a greater part of its heat from the earth, we find it colder and colder the higher we ascend in it. Hence, when those aqueous vapours are in the upper region of the atmosphere, by a special degree of coldness they become frozen, forming icicles among the clouds, which,

by the agitation of the wind, take the form of those floculent masses which we call *snow*. *Hail* is nothing but drops of water frozen in their descent, originating when the cloud is high, and the upper air extremely cold, they, losing their sensible heat, take the form of solidity. Before concluding this chapter, we must briefly notice the effect of hydrogen, which in all probability is not chemically united to atmospheric air, and from its extreme levity generally inhabits the upper regions of the atmosphere. It is very inflammable, and united with oxygen forms water. This substance, therefore, existing in the upper air, is by an electric spark arising from the re-establishment of an equilibrium of electricity between different clouds, undoubtedly the cause of those flashes of *lightning* we sometimes see darting from the clouds. *Thunder* may proceed from the explosion of these two substances, hydrogen and oxygen; and as rain always succeeds a thunder-storm, leaves no doubt of the formation of water by this atmospherical phenomenon.

We have before noticed, that vegetables when exposed to the solar rays, give out hydrogen; that is, they have the power of decomposing water. During which decomposition, its hydrogen uniting with the carbon of the vegetable, gives rise to the formation of oil, resin, bitumen, &c. while the oxygen, the other constituent of water,

participates of a portion of caloric; furnishing us with another method of obtaining vital air for the renovation of the atmosphere; so that this one operation gives nourishment and materials of growth to the vegetable creation, and at the same time promotes the salubrity of the air for the benefit of all animated beings. But it is not only our wants that it supplies, but it is subservient to our pleasures also; it ministers to every gratification we derive from our senses; without it we could not converse with each other, we should know nothing of sound, of smell, or of the variegated scenes that surround us. By it we are also kept from the sudden transition of light to total darkness; for, by looking through this dense transparent body, every celestial object that lies beyond it, is seemingly raised up; hence it is plain, was the atmosphere away, the sun would not be brought to view so long in the morning before it actually appears, but would, the instant it arose, appear one entire blaze of light, and leave us in total darkness the moment of its setting. The length of our twilight therefore must depend on the height of the atmosphere, which is estimated at 45 miles.

OF HYDROGEN.

Hydrogen is another elementary substance which has never yet been presented to us free

from combinations, but the singularity of its properties convince us of its existence. With oxygen it constitutes water, from whence it derives its name; it enters also into the composition of wax, resin, bitumen, fat, oil, and all vegetable and animal substances; with caloric it assumes the gaseous form, which is the simplest state it has yet been obtained in, forming hydrogen gas, or inflammable air. This gas is always obtained by decomposing water. It shews no signs of acidity, is void of taste, and, if pure, is destitute of smell. Hydrogen with oxygen forms water; with nitrogen, ammonia; with sulphur it forms an acid without oxygen; and with phosphorus, a gas exceeding all others in combustibility. Hydrogen gas is the lightest substance in nature, being thirteen times lighter than atmospheric air, on which account it is employed in aerostation, to inflate balloons. It being susceptible of such ready inflammation, made it useful in the construction of electrical lamps. Ether, alkohol, and other spirits, owe their lightness to this gas. Putrefying animal matter, stagnant pools, &c. generate it in hot weather, which getting ignited, gives rise to the Will-o'-the-Wisp, or ignis fatuus, &c. A number of interesting philosophical fire-works may also be exhibited with it, by means of bladders filled with it, and connected with jets, tubes, &c. bent into various forms, and pierced with dif-

ferent holes, the gas passing through them on pressing the bladder, may be inflamed, exhibiting many curious phenomena.

OF WATER.

Water, strictly speaking, is an oxide of hydrogen. Mr. Cavendish, to whom we are indebted for a knowledge of its composition, discovered that it contained 85 parts oxygen, and 15 hydrogen. In every 100, these two substances it appears unite only in that proportion in which water is the result. The composition of water by means of these two gases, is beautifully evinced by the experiments of Dr. G. Pearson, by means of the electric spark. Oxygen gas, and carbonic acid gas, are absorbed by water; it even separates oxygen from atmospheric air, from which it derives its agreeable taste, so different to the insipidity of boiling water, during which process the gaseous matter is driven off. It is a curious circumstance that water should contain more oxygen than any other substance, and yet not possess any of the acid properties. Water in an aeriform state, is applied to a number of important purposes. The invention of the steam engine is brought to such great perfection, that by one bushel of coal six thousand hogsheads of water may be raised ten feet high, and thus do the work of ten horses. It is incapable of lassitude; it works metals, moves

machines, and is the noblest drudge that ever was employed by the hand of art. Water may be decomposed by peculiar affinities, and even where it is imperceptible to the senses, as by the organs of plants, &c. In short, it is their chief nourishment, and forms the basis of the sap and all the vegetable juices. By water, the various salts, &c. (requisite for the formation and support of vegetables) are carried to them. Nor is this all; a greater part of the water is decomposed, the hydrogen participating of a portion of carbon, gives rise to the formation of oil, bitumen, &c.; and from these being always formed by the process of vegetation, it leads us to conclude, that those substances, wherever they are found, must have had a vegetable origin. While, on the other hand, oxygen, the other constituent of water, is employed in the formation of sugar, mucilage, fecula, vegetable acids, &c. Besides, a considerable portion transpiring when exposed to the sun, for the renovation of the atmosphere. Indeed the advantages derived from water are innumerable in domestic economy, in its forming a beverage for man, and its continual accumulation in the ocean, are of indispensable importance.

OF EARTHS AND ALKALIES.

We view with admiration the immense variety of bodies in the world, and their being composed

of so few primary substances; but our astonishment is more largely excited to see the almost infinite variety of earthy substances on which we tread, the hardest and largest rocks, and the most precious stones, constituted from nine elementary earths, and four of that number probably more regularly belong to the class of alkalies. Earthy substances have been divided into Simple and Alkaline Earths.

Simple Earths are dry, inodorous, and tasteless —incombustible fixed in the fire, and without some intervening medium, insoluble in 200 parts by weight of boiling water. Most of them unite with acids, like alkalies, depriving them of their acidity, and rendering them incapable of acting as acids; their specific gravity is generally four or five times heavier than water.

Alkaline Earths:—Lime, magnesia, barytes, and strontia, are of this class. These substances possess, in addition to most of the properties of simple earths, the characters of alkalies, having a strong taste, being more soluble in water, and turning vegetable blues green.

ALKALIES

Are three in number; they are distinguished by a pungent, acrid taste; the property of changing most vegetable blues green; soluble in water, and rendering oils miscible with water. They

are never found in nature free from combination. They are divided into volatile and fixed. 1. The Vegetable Alkali (Potash). 2. The Mineral Alkali (Soda, or Natron). 3. The Volatile Alkali, or Ammonia. The two former are termed fixed, from their not being altered by fire; the latter is called volatile, from its being easily dissipated by heat. They appear, from analogy, to possess one common base, for they have many properties common to them all: their ready union with acids, their solubility in water, the causticity of their taste, their rendering oils miscible with water, turning blue vegetables green, red into violet, yellow into brown, and their powerful attraction for water and carbonic acid, are characteristic properties of them all. They dissolve earths and metallic oxides, they corrode woollen cloth, and convert it into a kind of jelly. The tests for alkalies are syrup violets, tinct. litmus, infusion turmeric, &c.

OF COMBUSTIBLE SUBSTANCES, THE OXYDATION OF METALS, &c.

We have already observed under the head Combustion, that combustibles are substances that in common language are said to burn; and that this property in them is owing to their having a strong tendency to combine with the oxygenous principle—which is the base of vital air. They

may be divided into two classes, Simple Combustibles, and Combustibles more or less compound. Simple Combustibles are those which we have hitherto not been able to decompose, or reproduce, by artificial means. They exist generally blended with fossils, or in organic compounds: such are nitrogen and hydrogen, which we have just mentioned; also sulphur, phosphorus, diamond, and perhaps the metals. Sulphur—is a substance well known; it is found in the body and on the surface of the earth, both pure and in a state of combination; it is inflammable and acidifiable; it dissolves in hydrogen gas, and unites with the fixed and volatile alkalies, with most of the earths, and the generality of metallic substances, forming either alkaline, earthy, or metallic sulphurets.—Phosphorus—we have already noticed, page 51. It is generally obtained from the animal kingdom, though it is known to exist in minerals and vegetables. It undergoes combustion a few degrees above Zero, without heat. At 60 degrees it burns rapidly, with a quick and brilliant flame. It precipitates many metallic oxides from their solutions in a metallic state. It unites with sulphur and carbon. It combines also with the fixed alkalies, and with the earths forming phosphurets. Diamond—is generally considered to be pure carbon, and consequently the radical of the carbonic acid; if it be not, carbon has hitherto never

been obtained in a separate state. Guyton burnt the diamond in pure oxygen gas, and obtained carbonic acid without residue. Others have burnt it in like manner, and assert that water is also formed; if so, it must contain hydrogen; but this latter opinion is not generally believed. Plumbago is carbon oxygenized in the first degree; charcoal an oxide of the second degree; and carbonic acid the result of the complete oxygenation of carbon. Charcoal contains in a common state much hydrogen; that carburetted hydrogen is yielded, even after it ceases to yield carbonic acid. It powerfully resists the putrefaction of animal substances, and even restores them to sweetness when tainted. The union of carbon with other simple substances, form a class of bodies termed Carburets.

METALS

Form a class of bodies of the greatest importance and utility in the different purposes of life, Chemistry and Medicine. They are characterized by their great ponderosity, peculiar brilliancy, absolute opacity, and insolubility in water. From the closeness of their texture, they are capable of a high polish; and from the cohesion of their particles, they are highly proper for utensils, where strength is required to be combined with moderate bulk. They may be distinguished from earths,

which, under some circumstances, they in some degree resemble, by their much greater specific gravity, the lightest of the metals being near double the weight of the heaviest of the earths. Some of them are ductile, others are malleable; like other combustible substances, when heated in contact with atmospheric air, it decomposes it, the oxygenous part being absorbed, whereby the original characteristics of the metal are lost—they being reduced to the state of oxides. Some metals are oxydated with more difficulty than others. Gold, silver, platina, &c. will not unite with oxygen in the dry water, but at an exceeding high temperature; on this account they have been termed perfect metals. Some undergo oxidizement from mere exposure to the air, as manganese and arsenic; while others, as tin, lead, zinc, &c. require an increase of temperature. Different metals are capable of different degrees of oxygenation; some acquire by it actual acidity, as arsenic, molybdena, &c. But certain acids are more usually employed for the oxydation of metallic substances; in which case, the acid is decomposed by the metal absorbing its oxygen, becoming thereby a metallic oxide, which is either dissolved, and forms a metallic salt, or the metal is only corroded, and the oxide precipitated. Metallic solutions are decomposed by pure alkalies, which precipitate the metal in an oxidated state.

All metallic oxides are decomposed by carbon, when assisted by heat, from its greater affinity for the oxygenous principle, the metal being reduced to its metallic state. Sulphur unites with all the metals, excepting gold. Alkaline sulphurets also dissolve them, and the metal and sulphur will be precipitated together; in this case, the metal is in combination with sulphuretted hydrogen, and forms a class of compounds, termed hydroguretted sulphurets. Of this class are, the precipitated sulphur of antimony, Kerme's mineral, &c. An enumeration of the metals at present known, we have already given in the Table of Simple Substances.

Compound Combustibles are those which result from the union of Simple Combustibles with each other: as the sulphurets, the phosphurets, the carburets, &c.; also the different compound inflammable gasses. These constitute the major part of the class of Compound Combustibles. Art is constantly striving to separate them from each other, to obtain them pure and insulated.

Having taken a cursory view of the leading chemical agents, and pointed out the uses of the different articles composing the chemical chest, the manner of applying them to useful purposes;

the ultimate object of chemical investigation falls, next to be developed. In the hands of the professed chemist, they are employed in a general way, and all the operations equally attract his notice; but the other descriptions of persons to whom the chemical chest is necessary, in consequence of their particular pursuits, confine their objects in the use of it only to certain subjects. To no set of men is it more useful than to the professional character.

USE OF THE CHEMICAL CHEST TO THE MEDICAL PROFESSION.

The principal subjects for professional attention, are the examination of mineral waters, the detection of the administration of poison, and the sophistication of chemical and pharmaceutical preparations.

ANALYSIS OF MINERAL WATERS.

The various bodies that exist in mineral waters and give them their peculiar virtues, may be reduced to the following:

Carbonic		Carbonates in general.
Muriatic		Muriates in general.
Sulphuric	Acids.	Sulphates in general.
Sulphureous		Sulphurets in general.
Phosphoric		Iron.

Ammonia, or Volat. Alkali	Lead.
Barytes, Lime, Magnesia — Alkaline Earths.	Carbonic Acid Gas.
	Sulphuretted Hydrogen Gas.

From the predominance of one or more of these substances, mineral waters have been arranged under the titles of acidulous waters, saline and earthy waters, metallic waters, and sulphureous waters. In examining these, the detection of the predominant substance is the leading object, as on the action of this their medicinal virtues depend.

ACIDULOUS WATERS.

If the carbonic acid be predominant, it may be detected by the infusion of litmus, which will be reddened before boiling, but not afterwards. If it be the muriatic acid, it may be detected by nitrate of silver, with which it will form a white precipitate, which becomes black on exposure to light. If it contain the sulphuric acid it may be discovered by barytic water or acetite of lead, which will produce insoluble white precipitates. If the phosphoric be present, it may be detected by the nitrate, muriate, or acetite of barytes, the precipitate formed is soluble in muriatic acid without effervescence. If it contain sulphureous acid, it is indicated by the smell which it leaves, by being digested on oxid of manganese, and also by the infusion of litmus.

SALINE AND EARTHY WATERS.

When these waters contain the carbonate of potash or soda, which mineral waters seldom do, they are detected by the muriate of lime, which produces a precipitate soluble with effervescence in muriatic acid. If they contain ammonia, it may be detected by its smell, or by being suspended over muriatic acid, which produces a white vapour, or by sulphate of copper, with which it produces a dark blue coloured solution. If the water contain barytes, it may be detected by the sulphuric acid, with which it forms a white insoluble precipitate. Lime is frequently found in these waters both uncombined, and in a state of combination: in either case, the oxalic acid and the oxalates are the most sensible tests; it is also indicated by the sulphuric acid. If the lime be in an uncombined state, it may be shewn by blowing air from the lungs, which will form a pellicle at the surface, and by degrees fall to the bottom in the form of carbonate of lime.

Magnesia is also a common ingredient in mineral waters, in combination with sulphuric and muriatic acids. To detect the magnesia, add to the water a little pure ammonia, which will produce a white floculent precipitate. If the magnesia be dissolved by the sulphuric acid, it may be detected by the means before applied for that purpose. In like manner the muriatic. Should the carbonic

acid be the solvent, it becomes precipitated on boiling, and the precipitate soluble in the sulphuric acid. If any other earth than magnesia is suspected, it becomes precipitated by boiling, or by the addition of pure alkalies.

CARBONATES IN GENERAL,

By an effervescence, on adding sulphuric, nitric, or muriatic acid.

MURIATES IN GENERAL,

By their yielding a white precipitate on the addition of nitrate of silver, which precipitate turns black on exposure to light.

SULPHATES IN GENERAL,

May be detected, like sulphuric acid, by barytic solutions, or by acetite of lead, which produce white insoluble precipitates.

SULPHURETS IN GENERAL,

By acetite or nitrate of lead—polished metals, &c.

METALLIC WATERS.

Iron is a chief ingredient in mineral waters: it may be detected by the gallic acid, prussiate of potash, and succinate of ammonia; the first produces a black precipitate, the next a blue, and the latter a brownish precipitate. Lead may be detected by

a black precipitate on the addition of sulphuret ammonia, and a white one, on adding sulphuric acid.

SULPHUREOUS WATERS

Are those that discover sulphur to the smell. This substance is known to exist in mineral waters, in a variety of states, in the form of sulphuretted hydrogen gas, alkaline and calcareous sulphurets. The well-known Spa at Harrowgate belongs to this class. The presence of sulphuretted hydrogen gas, or any of the sulphurets, may be detected by acetite of lead, which produces a black precipitate; also, by their brightening the color of litmus paper, by their yielding a fetid odour on the addition of muriatic or sulphuric acid, and by their blackening polished metals.

Remark, when in the analysis the most accurate information is required, much aid cannot be derived from the slight sketch which is here given; to obtain such knowledge, the student is referred to the excellent works of Kirwan, Henry, and Accum.

ADULTERATION OF WINES.

Besides mineral waters, suspected wines are a subject of occasional investigation; and of all the means of adulterating them, that of the addition of lead is the most pernicious to the health of society. The investigation, therefore, should be

chiefly directed to the detection of this substance. It is well known that lead with vegetable acids produces a salt similar in taste to sugar, the same as the acetite of lead; and this taste is often imparted to acid wines, in order to correct their quality, and render them more palatable. To detect this adulteration of wines by the common test of sulphuret of ammonia, or potash, is a fallacious criterion, for a black appearance or precipitate is sometimes formed, even where no real adulteration prevails, and the characters of respectable dealers have thus too often been brought into reproach without any cause of blame on their parts. This, however, is entirely obviated in Dr. Hahnemann's wine test, which is thus prepared:

Take 15 grains of sulphuret of potass, and 20 grains of supertartrite of potass, and put them into a phial; fill it nearly to the top with distilled water, the phial being well corked, shake the ingredients together for the space of one minute, and then let them settle. This liquor precipitates all metals prejudicial to health, and has no influence upon iron, the most salutary mineral to the human frame.

This test, possessing all the requisite qualities, is thus applied to the examination of wine of a tainted quality. To two or three ounces of wine

add a spoonful of this wine test, newly prepared; if the wine be pure and without adulteration from any noxious mineral, it will continue transparent, and not in the least turbid; but if, on the contrary, it contain lead, or any other deleterious mineral, a dark precipitate will appear, in proportion to the quantity of deleterious matter present. If there be any iron in the wine, it may be discovered by adding a few drops of tincture of galls. In order to render the wine test still more satisfactory, dissolve in four ounces of any neat wine a few grains of acetite of lead, and in four ounces more of the same wine a few grains of the sulphate of iron, and nicely filter both solutions. By repeating the experiment with the same tests, or both, then the result will turn out as already stated. The proportion of lead contained in the precipitate of adulterated wines is 100 grains in every 150.

DETECTION OF POISONS.

This is a subject of the first consequence to a professional character, and the frequent occasion he has to judge of death from this cause, renders it a matter with which he should be thoroughly acquainted. The poisons most commonly resorted to for the purpose of suicide, are oxy-muriate of mercury and arsenic; for of each of these a very small quantity only, is necessary to produce death.

The muriate of mercury may be detected by the following experiments.

EXP. I.

Mix two or three drops of the solution of oxymuriate of mercury with half a wine-glass full of distilled water, no other alteration will ensue, but the liquor acquiring some tartness and a whitish hue; but if to a similar solution an equal quantity of lime water be added, then the mixture first acquires a dark yellow color, and then deposits a precipitate of the same cast.

EXP. II.

Take a wine-glass of distilled water, and add to it one drop of a solution of carbonate of potass, then drop a similar quantity into it of a solution of oxymuriate of mercury. The liquid will then become turbid, and deposit a white sediment. If the proportion of alkali be increased, yellow clouds are formed, and an orange colored precipitate descends in full proportion.

The presence of arsenic may be detected in the following manner.

EXP. I.

Take half a wine-glass full of distilled water, and drop into it a few drops of the solution of arsenic, then fill up the glass with lime water.

The liquor will immediately become turbid, and a white flaky precipitate be formed ; this precipitate being separated and steeped in oil, laid on red hot coals, will yield the usual garlic-like odor of arsenic.

EXP. II.

Drop into a wine-glass full of distilled water one drop of sulphuret of ammonia, and add to the mixture a few drops of the solution of arsenic. The liquid will become immediately turbid, and afterwards a precipitate of a yellow color settle to the bottom.

Such accidents, though more common to happen with the above minerals than any other, have often taken place from using other bodies of this class deposited in acids, which may require equally to be detected. Thus if by lead, it may be detected by similar means, as the sulphuret of potass, ammonia, &c. which produce a black precipitate. Copper will be precipitated of a blue color, by the addition of pure ammonia.

GENERAL RULE.

In order to discover the nature of the poison, the contents of the stomach should be collected in one mass, and brought into such a state that the tests may be properly applied.

Besides the analysis of mineral waters, the

adulteration of wines, and the detection of poisons, the purity or genuine quality of the medicines he employs, is a matter of the first consequence with the professional character; and these likewise should be submitted to proper tests with this view.

SULPHURIC ACID.

An impregnation of iron or copper often takes place in this fluid, from the process of preparing it, and sometimes of lead, if a sediment occur on dilution, it shews the presence of sulphate of lead or of lime. To detect iron, saturate a portion of it with carbonate of soda, and then add prussiate of potass, No. 14, which by its blue precipitate will shew it; or tincture of galls will give a purplish or blackish tinge; solution of pure ammonia, No. 12, will discover copper, and the sulphuret of ammonia, No. 33, will detect lead.

NITRIC ACID

May be rendered impure by admixture with the other mineral acids. The sulphuric acid may be discovered by adding to it a few drops either of the solution of barytes or of nitrate of lead, and the muriatic by a solution of silver. In the first case sulphate of barytes will be produced, or sulphate of lead, and in the latter muriate of silver.

MURIATIC ACID.

This acid may contain the sulphuric acid, or be impregnated with copper and iron. The sulphuric acid is discovered by the solution either of barytes or of acetite of lead. The presence of copper is detected by super-saturating the acid with pure ammonia, No. 12. Iron is discovered by saturating the acid with potass, and then adding to it the tincture of galls, No. 15.

BENZOIC ACID

Should have a fine crystalline white appearance, and a peculiar grateful smell. It should dissolve entirely in alkohol, and in a large quantity of boiling water; and when laid on heated iron, should be dissipated without residue.

SUBCARBONATE POTASH,

Known more commonly by the name of Prepared Kali, or Salt of Tartar, should dissolve entirely in twice its weight of cold water; any thing that remains undissolved may be considered an impurity. Sulphate and muriate of potash, siliceous and calcareous earth are frequently found in it. To ascertain the nature of the admixture, dissolve a portion in nitric acid, No. 7, diluted with an equal quantity of water; if any thing remains undissolved by this acid, it may be regarded siliceous. Nitrate barytes, No. 23, added to the solution will detect

sulphate potash, by a ponderous white precipitate; nitrate silver, No. 34, will discover the muriate potash by a white precipitate, which turns black on exposure to light.

Oxalate ammonia, No. 19, will detect calcareous earth, by forming a white precipitate, viz. the oxalate of lime.

PURE POTASH,

Sometimes termed Lapis Infernalis, when dissolved in distilled water, should not be rendered turbid by barytic water. If a precipitate ensue, soluble with effervescence in the muriatic acid, No. 6, it indicates the presence of carbonic acid. If the precipitate be insoluble, sulphuric acid is the admixture. Lime may be discovered, by blowing air from the lungs through the solution, which will render it turbid.

SUBCARBONATE SODA.

This salt, the prepared soda, prepared natron, &c. of the shops, is seldom or never free from muriate and sulphate soda. These may be detected in the same manner as directed for subcarbonate potash. Should the last mentioned salt be the adulteration, it may be ascertained by tartareous acid, which forms with potash an almost insoluble salt, the supertartrite potash; while with soda, the salt formed is very soluble.

SUBCARBONATE AMMONIA,

Termed also Prepared Ammonia, Volatile Salt, Salt of Hartshorn, &c. should dissolve entirely in water, and in dilute sulphuric acid. It should also be entirely volatilized when laid on heated iron.

SOLUTION SUBCARBONATE AMMONIA.

The liquor Ammoniæ Carbonatis of the Pharmacopœia, it should afford a strong coagulum with alkohol, No. 26; should effervesce with acids, and be of the specific gravity 1150.

SOLUTION PURE AMMONIA.

The pharmaceutical name for this preparation is Liquor Ammoniæ. It is a solution of ammoniacal gas* in water. It should contain no carbonic acid, which may be ascertained by its not effervescing with an acid. The presence of other salts may be detected by neutralizing the solution with nitric acid, No. 7, and adding the tests for sulphuric and muriatic acids.

SPIRIT OF HARTSHORN.

The Liquor Volatilis Cornu Cervi of the Pharmacopœia. It is frequently mixed with Liquor Ammoniæ, in order to increase its pungency, and

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* The purest form in which ammonia, or the volatile alkali exists, is in its combination with caloric in the form of gas.

to enable it to bear a larger dilution. This is ascertained by its not effervescing with acids. It should also afford a strong coagulum with alkohol.

SULPHATE SODA.

This preparation has been long known by the name of Glauber's Salt, from the person who first employed it. If it contain earthy salts, they may be detected by the carbonate potash, No. 4; if metallic salts, by the prussiate potash, No. 14. To discover muriate soda, add to a solution of the salt nitrate barytes, till no further precipitate ensues; afterwards nitrate silver, No. 34. It should not contain an excess of either acid or alkali; both of which may be detected by litmus, or turmeric paper.

NITRATE POTASH,

Called also Kali Nitratum, Salt Petre, Purified Nitre, &c. This salt is seldom free from muriate soda; sulphates of potash and soda are also occasional admixtures; the former is indicated by nitrate silver, No. 34, the latter by barytic solutions, in the same manner as subcarbonate potash.

MURIATE AMMONIA.

The commercial name of this salt is Sal Ammoniac. It is not unfrequently mixed with sulphate

ammonia, to detect which, muriate barytes, may be employed, which forms an insoluble white precipitate. Muriate ammonia ought also to be entirely volatilized when laid on heated iron.

MURIATE SODA

Is the common table salt, and from its mode of preparation, is seldom or never free from other salts, especially muriates of magnesia and lime, which may be precipitated by carbonate soda, No. 8.

SUPERTARTRITE POTASH,

Known more frequently by the name Cream of Tartar, is sometimes adulterated with Sal Polychrest (Sulphate Potash). This fraud may be ascertained by dissolving a portion of the salt in water, and adding to the solution muriate barytes, which forms a precipitate insoluble in muriatic acid, No. 6. It may also be detected by pouring a small quantity of water on the salt, and suffering it to stand a few minutes. The sulphate of potash being more soluble than the tartrite, will be dissolved, and may be known by the bitter taste of the solution.

TARTRITE POTASH AND SODA.

This triple salt is more frequently termed Ro-

chelle, or Seignette's Salt. Its most frequent adulteration is sulphate soda, which is readily discovered, by adding to its solution acetite lead, No. 18. If it contain the sulphate, the precipitate formed is insoluble in acetous acid.

SULPHATE MAGNESIA.

This valuable aperient, commonly termed Epsom Salt, from the name of the spring from whence it formerly was obtained in great abundance, is scarcely ever free from admixture, as the muriates of magnesia, lime, and soda, sulphate soda, &c. The former may be inferred, when the Epsom salt turns moist on exposure to the atmosphere; also, by a precipitation with nitrate silver, No. 34, after the sulphuric acid and magnesia have been separated by nitrate barytes. Lime is indicated by oxalic acid, No. 27; sulphate soda is by no means an uncommon sophistication; and when it only constitutes a part, is rather difficult of detection. The best means of ascertaining this is to precipitate the magnesia by the solution of pure ammonia, No. 12, with the assistance of heat, separate the precipitate by a filter, and evaporate the clear liquor to dryness, then expose the dry mass to a strong heat, which will dissipate the sulphate ammonia, while that of soda will remain.

SULPHATE IRON,

Formerly termed Ferrum Vitriolatum, Green Vitriol, Martial Vitriol, &c. This salt is not likely to contain any other admixture than copper, which may be known by the solution of pure ammonia, No. 12. rendering the liquor blue.

RED OXIDE MERCURY BY NITRIC ACID.

This preparation, termed frequently Red Precipitate, is liable to adulteration with red oxide of lead. This is detected by digesting it with acetous acid, and adding to the solution sulphuret ammonia, No. 33, which produces a precipitate nearly black.

WHITE OXIDE OF MERCURY.

The pharmaceutical name of this preparation is Hydrargyrus Precipitatus Albus. Chalk and white lead are the only probable adulterations; the latter is detected by the same means as the foregoing article; chalk by adding to the dilute solution oxalic acid, No. 2.

RED SULPHURET OF MERCURY,

Frequently termed Vermilion, factitious Cinnabar, &c. is mostly adulterated with red oxide of lead, which may be detected by the preceding rules; dragon's blood, and cretaceous matter, are also mixed occasionally with it; both of which

may be detected by their remaining unvolatilized when laid on red hot iron. The former is also known by its imparting to alkohol a red color; and the latter by effervescing with acetous acid, and affording a precipitate with oxalic acid, No. 27, when added to the acetous solution.

BLACK SULPHURET OF MERCURY.

This preparation formed by the mechanical triture of sulphur with mercury, has been termed Ethiop's Mineral. Its combination ought to be so intimate as not to communicate a white stain when rubbed upon gold. If adulterated with ivory black, it may be known by its not being volatilized by heat.

NITRATE SILVER

Is frequently termed Lunar Caustic. Its most probable admixture is copper, which may be detected by solut. pure ammonia, No. 12, imparting a blue color to the solution.

CARBONATE LEAD,

Known in commerce by the terms White Lead, Cerussa, &c. is sometimes adulterated with chalk. This may be ascertained by digesting it with acetous acid, and adding to the solution oxalic acid, No. 27.

SUPERACETITE LEAD,

Frequently termed Sugar Lead, ought to dissolve entirely in distilled water, if mixed with acetite lime or barytes; the former may be known by oxalic acid, No. 27, which produces an oxalate lime; the latter by sulphate soda, added to a solution very largely diluted with water.

GLASS OF ANTIMONY.

A most criminal imposition has been practised in selling for this article glass of lead. It may be detected by the following means: dissolve a portion of the true, and a portion of the spurious in the muriatic acid, No. 6; drop a little of each into a glass of water, the true deposits a white precipitate, the spurious remains clear. If into each glass a little sulphuret of ammonia, No. 33, be added previous to adding the water, then the precipitate from the true will be orange-coloured, and the latter will be nearly black.

VINEGAR (ACETOUS ACID)

May be mixed with the sulphuric, muriatic and tartareous acids. The first is discovered by the solution either of barytes, or of acetite of lead; the second by a solution of silver, and the tartareous acid by saturating the vinegar with carbonate potass, when cream of tartar will be separated in the form of a white powder.

DISTILLED VINEGAR, (ACETOUS ACID),

When impregnated with lead, may be detected by the wine test, also the sulphuret ammonia, No. 33, producing a precipitate of a thickish brown colour.

TARTAREOUS ACID.

This acid, if contaminated with the sulphuric, is readily manifested by adding to a solution of the tartareous acid, in distilled water, a few drops of the solution of barytes, in consequence of which sulphate of barytes is formed. It is also proved by the precipitate produced by acetite of lead not being soluble in nitric acid.

SALT OF AMBER.

The adulteration of this article, on account of its high price, is often made with sulphuric acid, and its compounds, also with tartareous acid, and occasionally muriate of ammonia.

The sulphuric acid is discovered by the solution of barytes or acetite of lead, a few drops of which are to be let fall into a watery solution of salt of amber. The tartareous acid will be shewn, if on the addition of a few drops of solution of potass, No. 11, a supertartrite of potass precipitates; muriate of ammonia is detected by the solution of nitrate of silver, No. 34.

ALUM.

Alum ought to consist entirely of alumine and sulphuric acid. Iron is detected by dissolving a little of the alum in distilled water, and adding a few drops of the prussiate of potash and iron, No. 14, or tincture of galls, No. 15, when in the former case a blue, and in the latter a black precipitate will be formed. Copper may be detected by pure ammonia, No. 12.

BORAX.

Borax is liable to be mixed with alum. It should totally dissolve in five times its weight of boiling alcohol, and when set on fire the solution should emit a green flame.

TARTARIZED ANTIMONY (EMETIC TARTAR)

Forms a white precipitate with the acetite of lead, No. 18, which is soluble again in nitric acid, No. 17. When dissolved in water a few drops of sulphuret ammonia, No. 33, produce a deep orange precipitate, viz. the golden sulphur of antimony.

OXYMURIATE OF MERCURY.

This preparation is apt to be adulterated with arsenic, which may be discovered by dissolving in water a small quantity of the preparation, when on adding the carbonate of ammonia, No. 9, a white precipitate will fall down; then filter the

liquor, and a few drops of the solution of ammoniated copper, No. 45, being added, a transparent blue liquor will appear if the preparation is genuine; but if a yellowish green colour, then arsenic prevails.

SUBMURIATE OF MERCURY (CALOMEL).

To ascertain the purity of this article, rub a little of it in a mortar with a little lime water, or the water of pure ammonia, when it ought to become immediately black. The purity of calomel may be also known by rubbing it with water in which muriate of ammonia has been dissolved; this liquor, when filtered, ought not to turn turbid on adding carbonate potash, No. 4.

MAGNESIA.

Magnesia should be free from any admixture with other earthy bodies. When adulterated with calcareous earth, it is easily discovered by the sulphuric acid, No. 5, which added to it will form an insoluble sulphate of lime; but when the magnesia is pure, the solution remains clear without any appearance of turbidness.

OXYD OF ZINC.

This is often mixed with common whiting, which is discovered by pouring upon it a little of the diluted nitric acid, No. 7, when the calcareous earth

will be dissolved with effervescence; and on the addition of sulphuric acid to the nitric solution, sulphate of lime will be precipitated.

MERCURY.

Mercury, if free from impurities, is entirely volatile in the fire, which it will not be if adulterated with lead, tin, or bismuth. Lead is detected by shaking the mercury with acetous acid, which gives the latter a sweetish taste, and by adding a few drops of sulphuric acid to the vinegar, a sulphate of lead will be formed. Tin is discovered by pouring nitric acid on the mercury, when a white oxide will be formed, and bismuth will separate from the mercury (if the latter is dissolved in dilute nitric acid) on the addition of distilled water a white precipitate will be produced.

SPIRIT OF NITRIC ETHER,

If pure, does not brighten the color of litmus paper, nor occasion an effervescence when added to a carbonated alkali.

ETHER.

This preparation ought not to contain any uncombined sulphuric acid, nor have the least sulphureous smell. The uncombined acid may be discovered by the solution of barytes, or by the

solution of acetite of lead. The former produces sulphate barytes, the latter sulphate lead.

ESSENTIAL OILS.

Essential oils are apt to be adulterated, either with oil of turpentine, or with an expressed oil, or with spirit of wine. The first of those adulterations may be perceived by the smell of turpentine, when a few drops of it are poured on a linen cloth, which is allowed to swing to and fro in the air; when the fine essential oil will fly off, and the oil of turpentine will remain. The second mode of adulteration will be discovered, by letting a few drops of the oil fall on paper, and exposing the paper to heat; in consequence of which, the fine oil will evaporate, and the exprest oil remain and leave a greasy spot. The best mode of adulteration with spirit of wine, may be ascertained by the addition of water, for if a little distilled water is mixed with such an oil, the water will unite with the spirit, and the quantity of fine oil contained in the mixture will then be separated. Essential oils mixed with spirit, are also detected by their not mixing with expressed oils.

METALLURGY.

METALLURGY is a subject which requires a particular application of the chemical tests; first, to know the presence of these bodies; and secondly, if present, to know how far they are worth assaying; and as it is only by solution in acids this can be done, the earthy matters with which they are united, and which are dissolved as well as the ores, renders it somewhat difficult.

GOLD.

To detect gold, it can only be dissolved in aqua regia, or the mixture of nitrous and muriatic acid. Ore, which is supposed to contain gold, is put into this fluid in a quantity sufficient to cover it, by which means the gold will be dissolved, and then the solution is to be diluted with distilled water. When this is done, a few drops of a solution of tin are added to this solution; the gold, if any present, will be discovered by a violet colored precipitate, termed the Purple Powder of

Cassius. This powder, when dried and mixed with calcined borax fuses, when urged by the blow-pipe, to a glass of a ruby color. On this account it is much used in the painting of genuine Porcelain. Gold is also precipitated from its solution, in a metallic form, by sulphate of iron.

PLATINA,

Like gold, is soluble in aqua regia, and may be precipitated from it by a solution of muriate of ammonia. By itself platina can be forced with the blow-pipe, or by means of oxygen gas only.

SILVER

May be separated from its ore, by the nitric acid, and precipitated from it by the muriatic and sulphuric acids, in the form of lunar cornea, and sulphate of silver. Copper precipitates it in a metallic form.

COPPER

Produces with the nitric and sulphuric acids, a blue solution. If a little of the solution of ammonia be poured upon a small portion of an ore that is suspected to contain copper, it will be tinged blue by it. The same takes place by the solution of the ore, in the nitric and sulphuric acids. By iron, it is precipitated in a metallic

form. When fused by the blow-pipe, it imparts a green color to the flame.

LEAD.

Lead, when contained in the ore, may be discovered by the acetous acid, which forms with it the acetite of lead; but it is more perfectly separated by nitric acid, from its ore; and from this solution, it may be precipitated by the muriatic and sulphuric acids, or by the neutral salts composed of them. By sulphuretted hydrogen, it is precipitated of a blackish brown color. By zinc, it may be separated from its solution in a metallic state. When urged with the blow-pipe, it froths up, and emits a yellowish light.

TIN

Is dissolved in aqua regia, and by the nitric acid, it is corroded to a saline state; exposed to the action of the blow-pipe, it is easily oxydated, and the different fluxes fuse with it to a white opake mass.

IRON

Produces with the sulphuric acid, a green, and with other acids, as the muriatic, a brownish solution; the solution has a peculiar astringent taste of iron. As an oxide, in which it is usually presented, it is dissolved with difficulty, by the

sulphuric acid; but more readily by the nitric acid, and aqua regia; and hence, these last acids are commonly used in examining a mineral containing much iron. By the vegetable alkali, it is precipitated of a greenish color; and by the prussiate of potash, of a blue color; but the former of these assumes a yellow color, on being dried in the air. With the astringent principle contained in vegetables, it assumes a black color. It imparts to the different fluxes, on being urged by the blow-pipe, a green color; but the higher degree of oxydation it receives, the nearer does it approach to the dark yellow hue. The oxyd of iron, on a piece of charcoal, urged by the blow-pipe, is brought into a state in which it is attracted by the magnet.

MERCURY

Generally appears in its native state, as a red sulphuret. It may be separated in this state, by boiling it with aqua regia, and then precipitating it by lime water, in the form of a yellow precipitate; exposed to the blow-pipe, it ought to fly off entirely.

BISMUTH

May be separated from its ore by nitric acid; and is precipitated from this solution in the form of a white oxyd, by the addition of water only.

With borax it fuses, on being urged with the blow-pipe, forming a glass-like mass, which, on being melted with charcoal, fumes, and emits light.

ZINC,

In its mineral state, is not readily discoverable; but, as a metal, is soluble in all the acids. When urged with the blow-pipe on a piece of charcoal, it burns with a bluish green color; and a white woolly oxyd is formed, called, flowers of zinc. In fusion, it gives a yellow color to copper, and may be afterwards separated from the copper again, by quicksilver.

SULPHURET OF ANTIMONY

Is extracted by the pure or caustic alkali, and from this solution, it may be separated by any acid. With muriatic acid, it forms butter or muriate of antimony; and may be separated from the acid, in the form of a white oxyd, by the addition of water only. Exposed upon charcoal to the action of the blow-pipe it flies off in white fumes; and amid the succession of bubbles, deposits beautiful flowers on the surface of any body that is held near it.

SULPHURET OF ARSENIC

Imparts a red color to sulphur, and a white one to copper. When pefectly oxygenated, it acts

like an acid. Exposed to the action of the blow-pipe, it flies off with fumes of a garlic-like smell.

SULPHURET OF COBALT

Is soluble in the sulphuric and nitric acids, as well as in aqua regia. With the sulphuric acid, it forms a red salt; the solution of it in aqua regia is of a rock blossom color, and if evaporated, yields a saline residuum, which becomes green when warmed; but loses its color as the salt becomes cold. From this latter property, it is used as a sympathetic ink. It fuses with borax when urged by the blow-pipe, forming a blue glass; and is the basis of the article called smalts.

NICKEL.

This metal, like copper, imparts a blue color to ammonia; but with the sulphuric and nitric acids form a green solution. When urged with the blow-pipe, it runs into a hyacinth colored glass. If it contains arsenic, it may be volatilized, when it produces a kind of vegetation.

MANGANESE

Has the property of oxygenating the muriatic acid; and produces a black oxyd, when urged by a strong heat; it parts with its oxygen again when digested with sulphuric acid, and gently heated.

USE OF THE CHEMICAL CHEST TO FARMERS AND COUNTRY GENTLEMEN.

IT is impossible to estimate the advantage a proper chemical knowledge would be to the farmer, if judiciously employed and joined to a full experience in agricultural pursuits. It is well known that much depends on the goodness and proper mixture of the soil with respect to the constituent parts; and a common division of soils has been accordingly made into the chalky, clayey, sandy, and mixed. The last is esteemed, justly, the preferable one for promoting vegetable growth.

A chalky soil is not the most fertile from preventing the sufficient spreading of the small fibres of the roots of the plants; and by being slowly penetrated by moisture, the second is the longer retained; and when dry, it, on the contrary, becomes too hard, and cracks. A sandy soil absorbs moisture too readily, and as readily parts with it.

It also receives more heat than another, and becomes accordingly deficient in moisture at all times. The mixed soil is preferable to the others, as uniting a proper proportion of lime, clay, and sand, in its composition; and neither absorbing too readily, nor retaining moisture too long, nor preventing, by its stiffness, the roots of the plants spreading, nor cracking so as to deprive them of nourishment. For these reasons, every farmer should be able to judge of the goodness or probable fertility of a soil, which is best done by chemical investigation of the substances the soil contains. One of the most frequent substances met with in soils, is lime.

1. LIME.

It is also applied as a manure, and the qualities of the lime render it more or less fit for this purpose. Dry and gravelly soils are impure or argillaceous lime, which suits them best, while stiff and clayey lands require a lime, on the contrary, as pure as possible. To determine the purity of lime, dissolve a given weight in diluted muriatic acid; adding a little excess of acid, to prevent any part being undissolved. Let the mixture be then diluted with distilled water, and the insoluble part, if any, subside, while the other liquor is decanted off. The sediment is then to be washed with farther portions of water, and

poured upon a filter previously weighed. On drying, the filter by its increase of weight, which will ascertain the quantity of insoluble matter contained in the experiment. The combination of magnesia with lime is reckoned a highly pernicious manure; and where the former abounds, it must be sparingly used. To ascertain magnesia in limestones, procure a Florence flask well cleaned by soap lees from oil, breaking it off about the middle of the body, by setting fire to a string tied round it, and moistened with oil of turpentine. Into the bottom of the flask let there be put 100 grains of the suspected lime, and pour on it by degrees half an ounce of strong sulphuric acid, No. 5. On each effusion of acid a violent effervescence will ensue. On its ceasing, stir the lime and acid together with a small glass tube, or rod, and place the flask in an iron pot filled with sand. Set it over the fire, and continue the heat till the mass becomes dry; then let the dry mass be scraped off, weighed, and put into a wine glass filled up with water. Stir the mixture, and after it has stood half an hour, pour the whole on a filtering paper placed in a funnel, and previously weighed. Wash the insoluble part with water as it lies on the filter, and add the washing to the filtered liquor. To this liquor a watery solution of half an ounce of carbonate potass, No. 4, may be poured; when, if magnesia be present, a very copious white sedi-

ment will ensue; if only lime, a mere milkiness will appear. If the former, heat the liquor by setting it in a cup near the fire, and when the sediment subsides, pour off the clear liquor to be thrown away, and wash the white powder, which is carbonate of magnesia, repeatedly with warm water, then pour on a filtering paper, dry and weigh it. On deducting 60 per cent. the quantity of magnesia contained in the lime-stone will be ascertained.

2. MARL.

The presence of carbonate of lime determines the fitness of marls for agricultural purposes, and hence the cause of their effervescence with acids, their distinguishing character. To ascertain marl, let a piece of it be dissolved in a glass of water, and when dissolved add a little muriatic acid, where, if it be marl, an effervescence will ensue. The composition of marl may be next formed by placing a few ounces of muriatic acid in a Florence flask in a scale, and let them be balanced. Reduce next a few ounces of dry marl into powder, and let this be gradually thrown into the flask, till, after repeated additions, no further effervescence ensues; let the remainder of the powdered marl be weighed, by which the quantity projected will be known. Let the balance be then restored, and the difference between the quantity projected, and the quantity necessary to restore the balance,

will shew the weight of the carbonic acid disengaged during the effervescence. If the loss amount from 13 to 32 per cent. the marl assayed is calcareous marl. Clayey marls, in which argillaceous earth prevails, lose only from 8 to 10 per cent. of their weight by this treatment, and sandy marl the same proportion. The properties of such marl may be tried by drying, after being washed with muriatic acid, when it will form brick. To determine with the most exactness the quantity of calcareous earth in a marl, let the solution in muriatic acid be filtered, and mixed with a solution of carbonate of potash, No. 4, till no further precipitate appears; let the sediment subside, wash it well in water, lay it on a filter previously weighed, and dry it. The weight of the mass will shew how much carbonate the quantity of lime submitted to experiment contained.

RULES FOR DETERMINING THE COMPOSITION OF A SOIL.

The substances found in soils, are certain mixtures or combinations of primitive earths, animal and vegetable matters in a decomposing state, certain saline compounds, and the oxide of iron.

The earths consist of silex or flinty matters; alumine the matter of clay; lime or calcareous earth and magnesia.

I. THE EARTHS.

1. Flint when perfectly pure appears in the form of a white powder, incombustible, infusible, insoluble, and not acted upon by common acids; it forms a principal part of hard, gravelly, sandy, and stony soils.

2. Pure alumine is also white, adheres when cold, strongly to the tongue, is incombustible, insoluble in water, but soluble in acids and in fixed alkaline menstrua; it abounds in clayey soils united with silex and iron.

3. Lime is known by its appearance as quick-lime; it always exists in soils in combination, chiefly with carbonic acid, thus forming a carbonate of lime, which in its compact form constitutes marble, and in its loose state chalk. When combined with sulphuric acid, it forms sulphate of lime (gypsum), and with phosphoric acid, phosphate of lime. The carbonate of lime, with other substances, composes chalky soils and marls. It is found also in soft sandy soils.

4. Magnesia forms a whiter and lighter powder than the others; it is soluble in acids, but not in alkaline menstrua. It is not often found in soils, but where it is, it appears in combination with carbonic acid, or with silex and alumine.

II. DECOMPOSING MATTERS.

1. Animal matter exists in different states, ac-

cording to the difference of the substances from which it is produced. It contains much carbon, and by heat may be principally resolved into that substance, ammonia, inflammable gases, and carbonic acid; it is found chiefly in lands lately manured.

2. Vegetable matter is also very different in kind, and differs from animal matters in not producing ammonia. It forms the chief part of peats; it abounds in rich mould, and is found in different proportions in all lands.

III. SALINE COMPOUNDS.

These are very few, and in quantities so small as to be rarely discovered. They are principally muriate of soda (common salt), sulphate of magnesia (Epsom salt), and muriate and sulphate of potash, nitrate of lime, and carbonated alkalies.

IV. OXIDE OF IRON.

The oxide or rust of iron produced by exposure of it to air and water, is found in all soils, but abounds most in yellow and red siliceous sands and clays.

INSTRUMENTS FOR THE ANALYSIS OF SOILS.

1. A balance so nice as to turn with a grain. 2. A coarse wire sieve so large as to admit a pepper-corn through it. 3. An Argand's lamp and

stand. 4. Some glass bottles and crucibles. 5. Porcelain basins. 6. A Wedgewood's pestle and mortar. 7. Filters of blotting paper, capable of containing a pint, greased at the edges. 8. A bone knife; and 9. an apparatus for collecting and measuring gaseous fluids.

REAGENTS FOR DITTO.

The reagents required are: Muriatic acid, No. 6.; sulphuric acid, No. 5.; water of pure ammonia, No. 12.; solution of prussiate of potash, No. 14.; tinct. soap, No. 44.; solution carbonate of ammonia, No. 9.; solution of oxalate ammonia, No. 19.; carbonate of potash, No. 4.; sulphuret of ammonia, No. 33.; and muriatic ammonia, No. 37.

COLLECTING OF SOIL FOR ANALYSIS.

In clays, the different specimens should be taken from different parts of the same field, two or three inches below the surface, and examined in the similarity of their properties. It occasionally happens in plains, that all the upper stratum is the same, when one analysis is sufficient; but in vallies, and near the beds of rivers, there prevails a great difference; even one part of the same field will be at times calcareous, and another part siliceous. In these cases, the portions must be submitted to separate experiments. Soils, when

collected for analysis, should be kept in glass bottles with ground stoppers, till examined.

The quantity of soil for experiment should not be less than 400 grains, collected in dry weather, and exposed to the air until it feels dry to the touch.

The specific gravity of a soil is thus ascertained: introduce into a phial a known quantity of water, with an equal quantity of soil, which is easily done by first half filling it with soil, and pouring in the water till the fluid rise to the mouth, the difference between the weight of soil and the weight of water will give the result; that is, suppose a phial holds 400 grains of water, the increase in weight, when filled with half soil and half water, gives the specific gravity; if it then weighs 600 grains, the soil will be 2 —, or twice the weight of water. This knowledge of the specific gravity is an indication of the quantity of animal and vegetable matters present, which are most abundant in the lighter soils. The good properties of soil may be known by the touch. Siliceous soils feel rough, and scratch glass. Aluminous adhere to the tongue, and give out a strong earthy smell. Calcareous are softer to the touch than aluminous.

CIRCUMSTANCES TO BE KNOWN RESPECTING SOILS.

1. Absorbent powers of soil. Even in its dried state, water is always contained in soils, and the quantity can only be determined by suspending it for ten or twelve minutes in a porcelain basin over Argand's lamp, in a degree equal to 300 of Fahrenheit. Though a small quantity of water may remain after the evaporation, it still affords useful comparative results. The loss of weight being carefully noted, determines the nature of the soil; if the loss in 400 grains reaches so high as 30, the soil is highly absorbent, and probably aluminous; and when the loss is only from 10 to 20, the soil is little retentive of moisture, and probably siliceous.

2. Separation of various matters from soil. When the water is driven off by heat, stones, gravel, and vegetable fibres should be removed from the soil, by passing it through a sieve, which will retain them behind, and the soil may be first bruised in a mortar to facilitate this. The weight of the matters retained by the sieve should be first noted down, and then examined. If calcareous, they will effervesce with acids; if siliceous, they will scratch glass; and if aluminous, they will be soft, and easily scratched with a knife—and not effervesce with acids.

3. Separation of sand and clay from loam. Be-

sides gravel and sand, most soils contain sand of different fineness, which must be detached from the more minute matters for examination. This is best done by agitating the soil in water, when the sand will fall immediately to the bottom, and the finer matters remain for a time suspended, so that by freeing the water from the bottom, after two or three minutes the sand will be powerfully separated from the other bodies, which, with the water containing them, must be poured into a filter, and after the water has passed through, be collected, dried, and weighed. The sand must be also weighed, and the respective quantities of each noted. The water must next be preserved, as containing the saline, mineral, and soluble vegetable matters of the soil.

1. EXAMINATION OF THE SAND.

The sand requires little consideration, and is either of a siliceous or calcareous nature, or a mixture of the two. If containing carbonate of lime, the muriatic acid by its effervescence will detect it; if a mixture, the respective quantities may be known by weighing the residuum after the action of the fluid, which should be continued till no effervescence can be raised. The residuum or siliceous part is then to be washed, dried, and strongly heated, and the difference between the

weight of it, and of the whole, tells the proportion of calcareous sand.

2. OF THE FINE LOAM, AND PARTICULARLY THE DETECTION OF LIME AND MAGNESIA.

The analysis of this part is the most difficult, from the variety it contains. The first part is to expose the loam to the action of the muriatic acid, and it should be poured upon the earthy matter in an evaporating basin, in a proportion twice the weight of the earth, diluted with double its volume of water. After being often stirred, the mixture should stand for an hour or two previous to examination. In this time, the carbonate of lime and magnesia will be dissolved by the acid, and also oxid of iron, but rarely any alumine. The fluid being passed through a filter, the solid matter collected is to be washed, dried, and weighed. Its loss will denote the quantity of solid matter taken up. The washings added to the solution, if not sour, must be made so by fresh muriatic acid, and a little prussiate of potash, No. 14, is then to be added to the whole. A blue precipitate then denotes the presence of oxid of iron, the prussiate is to be added, till no farther effect is produced. It is then to be collected and heated red for the result.

Into the fluid freed from the iron, a solution of carbonate of potash, No. 4, is to be poured till

all effervescence ceases, and till it acquires by taste and smell an excess of alkali.

The precipitate, which is carbonate of lime, must be collected on a filter, and dried at a heat below redness.

The remaining fluid being boiled for a quarter of an hour, when the magnesia, if any, will precipitate, combined with carbonic acid, and its quantity is to be ascertained in the same manner as the former.

If any particles of alumine should be discovered in the acid, it will be found in the precipitate, and may be detected by boiling it a few minutes with soap lye, sufficient to cover it, for it acts on alumine, not on carbonate of lime.

Where the loam contains much calcareous matter, this is simply ascertained by determining the quantity of carbonic acid the soil gives out, while it effervesces with the acid, either in weight or measure, which fixes the proportion of carbonate of lime. Where the diminution of weight is employed, two parts of acid and one of soil must be weighed in two separate bottles, and very slowly mixed together, till all effervescence ceases; the difference between their weight before and after the experiment shews the quantity of carbonic acid, for every 4½ grains of which 10 grains of carbonate of lime must be estimated. Where measure is employed, the pneumatic apparatus is

necessary, and there must be allowed for every ounce of carbonic acid two grains of carbonate of lime.

3. OF THE DETECTION OF ANIMAL AND VEGETABLE MATTER.

After the action of the muriatic acid the loam is next to be submitted to the crucible, in the strong heat of a common fire, till it shews no blackness in the mass, to ascertain the animal and vegetable matter. It should be constantly stirred with a metallic wire during the process, and the loss of weight it undergoes determines the quantity of the substance it contains destructible by these means. Whether this substance be animal, vegetable, or a mixture of both, it is impossible correctly to ascertain. A blue flame at the time of ignition denotes vegetable matter, while an empyreumatic smell like burnt wool, indicates the presence of animal matter.

OF THE SEPARATION OF ALUMINE, SILEX, AND OXIDE OF IRON.

For the separation of these from each other let the solid mass be boiled with dilute sulphuric acid, which will dissolve the alumine and oxide of iron—should there be any residuum it may be considered silex. Carbonate of ammonia added to the solution will precipitate the alumine, and

leave the iron, which may be afterwards separated by boiling.

OF THE DETECTION OF SOLUBLE ANIMAL, VEGETABLE, AND SALINE MATTER.

All substances that are soluble may be obtained by boiling the soil in a quantity of distilled water, and evaporating the lixivium to dryness. If the mass be of a brown color, and inflammable, it may be considered as partly vegetable extract; and if it smells strongly empyreumatic when heated, it may be regarded as partly animal matter. Saline substances are easily distinguished by their taste, white color, and semi-transparency.

OF THE DETECTION OF SULPHATE LIME, SULPHATE BARYTES, AND PHOSPHATE LIME.

To detect the two former, they must be suffered to remain some time in contact with a carbonated alkali, as the carbonate potash, No. 4, exposed to a gentle heat, whereby a double elective attraction ensues. One of the new compound sulphate potash being soluble, may be washed away; the other will be found to be a direct carbonate from the union of the carbonic acid of the alkali with the lime, or the barytes—which may then be examined with the tests before mentioned.

Phosphate of lime may be discovered by digesting the soil with muriatic acid, No. 6, more than

sufficient to saturate the soluble earths; the solution must then be evaporated to dryness, by pouring water upon the dry mass, all the earthy muriatic salts will be dissolved, and the phosphate lime left untouched.

GENERAL REMARKS.

A well-grounded knowledge of chemical attractions is in the analysis of soils, indispensably necessary, in order to separate and ascertain with accuracy, the proportion of the component parts of such an endless variety of complicated substances; but this extreme nicety is not absolutely necessary in a general way, what the chemical agriculturist will be principally desirous of ascertaining are the predominant ingredients his soil may consist of, and whether they are calculated for the fertility of his crop; some little knowledge of which he may derive from the foregoing rules. When he has completed the examination of a soil, the products should be classed, and their quantity added together, and should they nearly equal the original quantity of soil employed, the analysis may be considered as pretty accurate. Persons unacquainted with chemical science, must not in

their first attempts expect much precision of result. Many unexpected obstacles will be found to arise, but when once a little theoretical knowledge is acquired, and connected with a few practical operations, such difficulties will speedily be overcome; and nothing is more instructive in experimental science than the detection of mistakes. In short, in order to be well grounded in chemical information, no better mode perhaps can be adopted than that of attempting original investigations. The scientific farmer is sensible that the constant improvements making in his profession are owing to the daily improvements in chemistry; he is aware they have taught him the necessary food of plants, and the art of correcting and improving soils, so as to render them fit for vegetation. He also knows the nature of a soil cannot be discovered by other than chemical investigation; how requisite is it then for every cultivator of land to possess at least some knowledge of chemistry.

OF MANURES.

The substances by which the vices of a soil are corrected, are termed manures, and which of course are varied according to the nature of the soil. For *Clayey Soils*, the best manure is marl with limestone gravel, or marl and dung; where these cannot be obtained, sand, lime, coals, burned

clay, gravel, or even pebbles, are useful. For *Chalky Soils*, the best manure is clayey, or sandy loam. For *Sandy Soils*, the best manure is calcareous, or clayey marl; or calcareous or clayey loams.

For ferruginous and vitriolic soils, calcareous earth is necessary. Gypsum is an excellent manure, from its accelerating putrefaction. Carbonate lime, and red oxide of iron are likewise useful in promoting vegetation. Charcoal itself has also been successfully used. The agriculturist will derive considerable advantage from the study of Professor Davy's Elements of Agriculture.

USE OF THE TESTS TO THE MANUFACTURER.

The perfection of goods got up for market, depends much on the purity of the articles the manufacturer employs, and accordingly the means of judging of these he should always have in his power. It is on the purity of the materials from which arises the difference in the productions made in one country and another. The original manufacturer, attentive to this circumstance, gains a character, and fixes the reputation of his articles. While others, inattentive to this particular, seldom or never succeed in their undertaking. The failure of processes, especially those of a chemical nature, is generally owing to very

trivial circumstances. Chemistry puts it in the power of the manufacturer to judge of the genuine nature and strength of every article he employs. Its utility, therefore, cannot be too highly prized, as giving him every advantage in carrying on his concern. The rules already given for ascertaining the purity of different articles, as well as the directions for analyzing different substances, will be found, on a proper application, to be deserving his most serious attention. The processes of dying, bleaching, coloring, distilling, &c. &c. will be in some degree explained under the head of Domestic Chemistry.

THE

USE OF THE PORTABLE CHEST

OF

CHEMISTRY

TO THE

AMATEUR AND DOMESTIC CHEMIST.

HAVING considered the application of the tests, and their utility to certain professions, it will not be superfluous to examine them also as they are adapted to various purposes of domestic life, as well as to contributing to the pleasure and amusement of society. Under this head might be included the greater part of domestic economy, as brewing, distilling, the making of cider, perry, vinegar, wines, &c. &c. all of which depend upon

chemical principles; also dying, staining, bleaching, removing stains, manufacture of colors, fumigation of rooms, varnishes, wax, inks, cements, silvering, gilding, &c. &c. To this we may add, a collection of interesting and instructing experiments, which, at the same time they excite admiration, raise the mind to the contemplation of that Power,

"At whose most potent nod, effect and cause
Walk hand in hand, according to his laws;
Rise at Volition's call, in groups combin'd,
Amuse, delight, instruct, and serve mankind."

In order to understand more clearly many of the subsequent phenomena, it will be necessary to give a brief description of vegetable substances.

OF VEGETABLE SUBSTANCES.

By Chemistry we are also enabled to investigate the properties of living and organized beings, as vegetables and animals, as well as the inanimate parts of nature. The elementary substances that enter into the composition of vegetable substances are comparatively few. Oxygen, hydrogen, carbon, and nitrogen, are the constituents of them all. They differ from minerals in this, that they are extremely susceptible of analysis, or decomposition, but not one is an object of synthesis.

The physiology of both vegetable and animal substances is, perhaps, foreign to the present subject; but though we cannot regard it as a chemical process, we are still able, by examining chemically the changes they undergo, to obtain some knowledge of the principles on which they depend. Chemistry, however, is more immediately concerned with them when they cease to live; it treats of the substances of which they are composed, and of the changes which these substances undergo. It is to this part, therefore, that we shall more immediately confine our attention. The principal substances met with in vegetables are the following:

Sugar.	Extract.	Fecula.
Gum.	Gluten.	Caoutchouc.
Mucilage.	Oils.	Wood.
Jelly.	Wax.	Coloring Matter.
Tan.	Resin.	Suber.
Starch.	Gum Resins.	Alkalies.
Indigo.	Camphor.	Acids.

Sugar, more or less, forms a part of all vegetables, but more abundantly in some than in others. It is the produce chiefly of the sugar-cane in the West Indies, and the sugar-maple of America. It may also be extracted from the birch, wheat, corn, carrot, beet, parsnips, grapes, &c.

by digesting in alkohol, which dissolves the sugar, and leaves the extractive matter untouched. Sugar is a true salt, easily decomposed both by heat and mixture. Its component parts are in every 100—oxygen, 64; carbon, 28; and hydrogen, 8. When allowed spontaneously to crystallize, it forms the article sugar-candy. It is easily fused, and when suffered to cool, forms the substance called barley-sugar. It renders oils miscible with water. By fermentation it forms alkohol and acetous acid; when deprived of its oxygen, it bears a resemblance to gum. So profusely is the saccharine matter diffused throughout nature, that we see bees collect it from the flowers of plants. Honey, however, differs from pure sugar, in containing mucilage and an acid.

Gum is a transparent, tasteless substance; it exudes from different parts of vegetables, but chiefly from the trunks and branches of trees. It is generally considered inspissated mucilage, which in its chemical properties it exactly resembles. Gum is insipid, soluble in water, insoluble in alkohol, and coagulable by the action of acids and metallic solutions; exposed to the fire, it emits carbonic acid. Its elementary principles are: oxygen, hydrogen, carbon, nitrogen, and lime, with a small portion of phosphoric acid.

Mucilage is frequently found exuding spontaneously from certain trees; it has all the properties

of gum, which it appears to be in a less solid form. By coction with water, it is yielded in great quantities by lichen, althea, malva, &c.

Jelly is also a kind of gum, with vegetable acid. It exists in many fruits, particularly in the juice of raspberries, blackberries, currants, &c. Jelly, in a state of purity, is nearly colorless and tasteless. The property of jellying is lost by long boiling.

Tan, or the astringent principle, is a very important part of vegetables, and is of considerable use in the arts. The skins of animals are rendered by it imputrescible and insoluble in water; it generally accompanies the gallic acid in nut-galls, &c. Oak bark, catechu, and kino, &c. contain it in considerable quantities. It may be obtained free from combination, by precipitating a strong infusion of oak bark with muriate tin, No. 16. This precipitate consists of tannin with oxide tin, from which it may be obtained pure, by diffusing it through water, impregnated with sulphuretted hydrogen. It may also be obtained by adding lime-water to the infusion, and re-dissolving the precipitate in nitric acid, which dissolves the lime, and separates the tannin. It unites with alkalies, but is precipitated by acid. The most singular property of tan is its affinity for animal gelatine, which it separates from its solution in water, in a tough, insoluble state, resembling lea-

ther. The skin of animals consists almost entirely of gelatine, more or less hardened with this principle. It may be exemplified, by adding a solution of tan to a solution of common glue, or isinglass. On the same principle is founded the process of making leather.

Starch exists in all kinds of grain, as wheat, barley, and also farinaceous roots—as the potatoe, the sago plant, &c. It is usually obtained from wheat flour, which consists entirely of starch and gluten. In malting, a great part of the starch contained in the barley is converted into sugar. Dr. Thompson considers, during this process, oxygen is absorbed, and carbonic acid emitted; whence it is probable, that starch is converted into sugar, by diminishing its proportion of carbon, and increasing that of its hydrogen and oxygen. Its distillation shews us, that it contains no other ingredient than these three.

Indigo is obtained as a fecula from several varieties of the plant Indigofera, in the East and West Indies, by fermentation. It may likewise, by the same means, be prepared from woad, a plant well known in this country; its component parts are oxygen, carbon, hydrogen, and nitrogen.

Extract exists abundantly in the juice of all plants, and may be obtained by inspissating an infusion or decoction of any vegetable. It varies in color, taste, &c. in consequence of the admixture of other principles. Acetous acid, acetites

of potash, lime, and ammonia, are constantly found in it. Extract has a strong affinity for oxygen; and, when pure, appears to be an oxide with a triple base; being a compound of carbon, hydrogen, and nitrogen, with a portion of oxygen, not sufficient for its saturation, and is therefore capable of absorbing much more than it originally holds.

Gluten forms a part of all farinaceous vegetables. It may be obtained abundantly from wheat flour, by kneading it under water until the fluid carries off all the starch, and ceases to be colored by it. It very much resembles animal glue; on which account it has been termed the vegeto-animal substance, and yields, like animal substances, carbonate of ammonia by distillation, and when exposed to the air, soon putrefies. Oxygen, carbon, hydrogen, and nitrogen, are its constituent principles.

Oils are obtained from various vegetable substances, either by pressure or by distillation. They are inflammable and immiscible with water, and are composed of hydrogen, oxygen, and carbon. Those obtained by distillation contain much of the former, and those by pressure much of the latter. Those obtained by distillation are termed volatile, or essential oils; those by expression, fixed, or fat oils. The oily principle appears to be the same in them all. In the fixed,

it is united with mucilage; in the volatile, with aroma. The volatile oils of vegetables dissolve readily in alkohol, and give rise to a class of substances termed essences: as essence peppermint, cinnamon, lavender, roses, &c. Fixed oils are generally obtained from seeds or kernels, by expression in proper sacks between metallic plates. Heat is sometimes employed to assist the separation; when it is not, the oil is said to be cold-drawn. Oil readily combines with oxygen;—its combination with the oily principle forms drying oil. When its combination is with the mucilage, it forms rancid oils. Oil unites also with metallic oxides, as oxides of lead, mercury, &c. forming PLASTERS, UNGUENTS, &c. An imperfect combustion of oil forms the article Lamp Black. With certain media it mixes with water, forming a milky fluid termed an *Emulsion*. Alkalies unite with the fixed oils, and convert them into soap, rendering them thereby miscible with water. MOTTLED SOAP is formed of tallow, kitchen grease, and soda; WHITE SOAP from tallow and a lixivium of soda; YELLOW SOAP, with tallow, rosin, and soda; SOFT SOAP is formed with lixivium of potash, and fish oil; when it is combined, a small quantity of tallow is added, which occasions the white spots. Fixed oils will also dissolve sulphur, forming a fetid compound, termed BALSAM, OR OIL OF SULPHUR. Phosphorus they also dissolve, forming the phosphuretted oil, which causes

the hands, or any part of the body, to appear luminous in the dark. Essential oils have a greater affinity for oxygen than the fixed oils, acquiring thereby color and consistence, and pass to the state of resins. Water dissolves a small portion of essential oils, receiving from them both taste and smell, as appear in the distilled waters. Alkalies unite with them and form soaps; they also dissolve sulphur and phosphorus.

Wax, though collected by bees, is in reality a vegetable substance; it covers and polishes the surface of some leaves, as those of the laurel; it appears to have a fixed oil for its base, and which passes to the state of resin by its combination with oxygen. Alkalies form with it a saponaceous compound; ammonia dissolves it, and forms a varnish. One hundred parts of wax contain 82 parts carbon, and 18 hydrogen.

Resins are oxygenated essential oils; that is, volatile oils rendered concrete by their union with oxygen, and probably deprived of a part of their hydrogen; they are soluble in alkohol and oils.—Water precipitates them from their alkoholic solutions; they are soluble in several of the acids, and in pure alkalies. Turpentines are resins containing volatile oil.

Gum Resins are a class of substances composed of resin and mucilage—as aloes, gum ammoniacum, asafetida, scammony, &c. They are there-

fore partly soluble in water, and partly in alkohol; proof spirit, consequently, becomes their proper menstruum.

Camphor, is a volatile oil, rendered concrete by carbon; it is crystallizable either by sublimation or crystallization. It is obtained from a species of laurel that grows in China and Japan—is soluble in alkohol and oils.

Fecula, sometimes termed Farin. It constitutes the greater part of all nutritive grains. To extract fecula, the plant is bruised and diffused in water, which fluid becomes milky, and the fecula subsides. Thus are obtained arrow-root, potatoe flour, starch, sago, &c. Paper is also a fecula.

Caoutchouc, or Elastic Gum, is extracted from the hœoea and jatropha, two trees of South America, from which it exudes in the form of a milky juice. On exposure to the air it absorbs oxygen, and becomes concrete. Its constituents are carbon, hydrogen, oxygen, and nitrogen.

Wood is composed of carbon, oxygen, hydrogen, nitrogen, and lime. It is also well known to consist of a multitude of longitudinal fibres, possessing combustibility, insipidity, and insolubility in water.

Coloring Matter exists in vegetable substances in combination with extract and mucilage; in which case it is soluble in water; when combined with farina, an acid is necessary; when with resins, it requires an alkali or alkohol. On the se-

paration of this principle depends dying, calico printing, &c.

Suber, or *Cork*, is the outer covering of the Quercus Suber. It is combustible, and by the action of the nitric acid, may be converted into an acid termed the suberic.

Alkalies. The only alkalies found in vegetables are potass and soda.

Vegetable acids have all carbon and hydrogen for their base, with oxygen for their acidifying principle. Their different properties and habitudes are owing to the different proportion of these principles. The vegetable acids are the Citric, Tartareous, Malic, Gallic, Benzoic, Oxalic, Mucic, Camphoric, Suberic, Prussic.

OF FERMENTATION.

Vegetables are decomposed when exposed to the combined action of water, heat, and air; during which decomposition oxygen is absorbed and caloric disengaged. Fermentation is divided into three species—the Saccharine, the Vinous, and the Acetous.

SACCHARINE FERMENTATION

Is the first chemical change that vegetables undergo, when placed under the just mentioned circumstances. Thus the insipid matter of seeds, on imbibing moisture, speedily germinates, and becomes a direct saccharine substance; on this is founded the

process of Malting. Barley is first macerated in water, then piled up until such time as germination takes place, which is afterwards stopped by drying in a proper kiln. To this process the saccharine property in malt is owing. The sweetness in fruit that has been long kept, originates from the same cause.

VINOUS FERMENTATION.

This species of fermentation always terminates in the formation of spirit—as alkohol, wine, beer, &c. For this process, the presence of the saccharine principle is absolutely necessary; also water, and a vegetable acid. The phenomena that attend the vinous fermentation are—when brought to a certain heat, an intestine motion ensues, the mixture becomes muddy, the temperature increases, and carbonic acid is liberated, and remains above the fermenting liquor. When the fermentation ceases, the saccharine flavor is lost, its gravity is diminished, and spirit is formed; the liquor becomes bright and clear, obtains a vinous odour, and certain intoxicating powers. Even after this an imperceptible fermentation goes on, which occasions the difference between new and old wines. If the fermentation be stopped at its height, by the exclusion of air, as in bottling, the wine on the first opportunity lets the imprisoned gas, formed after its seclusion from the air, escape rapidly, as in Champaigne wines, cider, perry,

&c. Alkohol, the product of the decomposition of sugar (affected by the introduction of yeast, which contains a vegetable acid and gluten) exists more or less in all wines. Beer is formed on similar principles: the saccharine matter of malt is extracted by maceration in hot water, the strained infusion is afterwards boiled with hops; the decoction is then cooled to a certain point, as quick as possible, to prevent the acescent fermentation. When the liquor is about the warmness of new milk, a small quantity of yeast is added, which in a few hours excites fermentation. After standing a sufficient time (about 24 hours) it is put in casks, and when fermentation ceases, is secluded from the air. The fermented liquors yield, on distillation, an ardent and inflammable spirit—such as Rhenish and French brandy, rum, malt spirit, &c.

Alkohol is obtained by the rectification, or redistillation, of either of these spirits with a fixed alkali, which absorbs the aqueous part, and leaves the spirit. Its component parts are hydrogen, carbon, and oxygen. Ethers are obtained by distilling alkohol with sulphuric, nitric, or muriatic acid—forming sulphuric ether, nitric ether, &c. Alkohol dissolves resins, volatile oils, soaps, &c. By the solution of resins in alkohol Varnishes are formed.

Mastic Varnish, is one part pure gum mastic, dissolved in four parts alkohol.

Shellac Varnish, is prepared by dissolving one part shellac in four parts alkohol.

Gold Varnish, frequently termed Lacquer, is made by adding to eight parts mastic varnish, with one part gamboge, and the same quantity of arnatto, with a grain of dragon's blood.

Black Varnish, is formed by adding fine lamp-black to mastic varnish.

ACETOUS FERMENTATION

Consists in the absorption of oxygen, by the mucilaginous principle of vegetables. Wine or beer, for example, when exposed to a heat of between 70 and 80 degrees, in contact with air, lose their taste and smell, and become sour, and form vinegar. If wine be allowed to continue too long fermenting, it runs into the acetous fermentation. The growing sour of milk, is also a true acetous fermentation. The process by which bread is formed, appears to be the commencement of a spontaneous decomposition, which, if it were not checked, would terminate in putrefaction. The dough passing into a state of fermentation is called *Leaven*, and if it be baked before sourness is discoverable, good bread is formed.

OF DYING.

Dying, or the art of imbuing stuffs, &c. with various pigments afforded by the vegetable, mineral, and animal kingdoms, is founded entirely on chemical principles, though generally considered a process of the domestic kind. The article to be dyed, previously to its being submitted to the coloring matter, undergoes a preparatory process, that is impregnated with a substance termed a mordant—of which there are several: sulphate alumine, supertartrite potash; nitro-muriate tin, oxymuriatic acid, astringent principle, acetite alumine, sulphate copper, sulphate zinc, acetite copper, arsenious acid, &c. The way in which these mordants exert their efficacy, seems to consist in their yielding a portion of their oxygen, whereby the substance of the stuffs, &c. is in some degree altered, and its attraction for the pigment increased; on this account the colors of the pigments suffer various alterations, and receive various shades, by these intermedia. Which of the mordants may be best for any particular color, can be pointed out by experience only.

BLUE DYE.

Indigo is generally the substance used for this color, dissolved in sulphuric acid, in the following manner: one part of finely powdered indigo

is added to eight parts of concentrated sulphuric acid, in a glass vessel, and submitted to a gentle heat in a water bath; it is then very largely diluted with water.

Litmus, is another blue pigment. It is supposed to be the bastard ricinus, or turnsole plant. The natural color of this substance is not blue, but red, which latter color it regains by the action of acids. Its blue tinge is owing to its being immersed in urine, lime-water, and potass, or soda. Logwood, Brazil wood, and alkanet root, will form blue dyes when treated with an alkali.

RED DYES.

Cochineal, Brazil wood, archil, madder, and carthamus, are the substances generally employed for this color. Of these the cochineal is the most beautiful; sulphate alumine brightens the color of its decoction, and occasions a crimson precipitate. By the nitro-muriate tin, the whole of the coloring matter is precipitated of a beautiful red.

Brazil wood, archil, and madder, like cochineal, have so slight an affinity for the cloth as to impart no permanent red, without the assistance of mordants—as sulphate alumine, nitro-muriate tin, &c. Supertartrite potass and muriate soda, are not unfrequently employed as auxiliaries.

YELLOW DYES.

Quercitron bark, fustic wood, turmeric, French berries, and carthamus, are the substances most frequently employed for yellow dyes. The coloring matters of these substances have, like reds, too slight an affinity for cloths, to produce any permanent color without the use of mordants. The article to be dyed must, therefore, be prepared accordingly; the mordant most commonly used is sulphate alumine. When the color is required particularly fine, the muriate of tin is employed; tannin is not unfrequently employed as a subsidiary to alumine, in order to fix it more copiously on cotton and linen. Supertartrite of potash has the property of brightening the color. Muriate soda, sulphate lime, and sulphate iron, are used as occasional auxiliaries, to deepen the shade. Fustic wood affords the most permanent color, but not so beautiful as the quercitron.

BLACK DYE.

Tannin, or the astringent principle with oxide of iron, affords the best and most permanent of the black dyes. These two substances have a natural affinity for each other, and, when combined, assume a deep black color, not liable to be affected by the action of light or air. Logwood is mostly added to them as an auxiliary: it commu-

nicates lustre, and adds considerably to the fulness of the black. The article to be dyed is, therefore, first to be boiled in a decoction of nut-galls, and afterwards steeped for a few hours in a bath, composed of logwood and sulphate iron, at a heat a few degrees below boiling. When taken from the bath, it must be exposed as much as possible to the action of the air, which considerably improves its color.

BROWN DYE.

Shumac, the green covering of walnuts, and the bark of the birch tree, are the substances mostly used to produce a brown. The walnut-peels are generally kept some considerable time, covered with water. When they are used, nothing more is necessary than to steep the cloth in a decoction of them. The reason why no mordant is required to shumac, &c. is, that the coloring matter in these substances is already combined with the astringent principle.—The tannin having an affinity for the cloth, and the coloring matter an affinity for the tannin.

GREEN DYE.

This is a compound color, produced by mixing together two simple ones, as blue and yellow. The most simple method is to dye it blue first,

and afterwards yellow. By this means the shade may be raised from sea-green to pea-green.

ORANGE DYE.

This also is a compound color, formed of a mixture of yellow and red. If this mixture be mixed with blue dye, the resulting color is olive. Blue and red mixed in different proportions, produce violet, purple, lilac, &c. Black, with other colors, constitute drabs, greys, browns, &c.

NANKEEN DYE.

Arnatto dissolved in water, with carbonate potash, or a little pearl-ash, is the base of all the nankeen dyes that are offered for sale; and which, if the arnatto be good, forms an elegant color.

The juice of aloes produces a lively violet, highly proper for works in miniature, and which may serve either cold or warm for dying silks, from the lightest to the darkest shade. Ann. de Chemie. xxv.

CALICO PRINTING

Consists in impressing the mordant in the desired forms on the cloth, and afterwards subjecting it to the coloring matters. These become fixed where the mordants have acted, and being easily washed out from the other parts.

STAINING,

Is the art of dying or tingeing certain substances, with different coloured matters—as wood, paper, &c.

STAINING WOOD.

For this purpose, corrosive and penetrating substances are necessary, as the different acids, sulphate iron, copper, &c. according to the nature of the wood.

Red.—To stain wood this color, it must be immersed some time in a solution of alum and water, and then put into a decoction of Brazil wood in lime-water.

Blue.—The best means of giving this color to wood, is by a diluted solution of indigo in sulphuric acid.

Green.—A decoction of acetite copper (verdegris), and muriate of ammonia, in acetous acid, affords the best green.

Black.—A strong decoction of logwood and galls, with sulphate iron and acetous acid, forms a jet black.

Nitrate iron, gamboge dissolved in spirit of wine, and dragon's blood dissolved in the same fluid, also tinge wood of different colors.

Yellow.—An infusion of turmeric root in rectified spirit of wine, stains paper a most beautiful yellow, without injuring its texture. A decoction of French berries, with sulphate of alumine, affords a permanent yellow.

Red.—This color for paper is best prepared by digesting for two or three days two parts of dragon's blood in four parts rectified spirit of wine.

Blue.—A diluted solution of sulphate of indigo, gives to paper a beautiful blue color, which may be made either deeper or lighter at pleasure.

Pink.—This color cannot be prepared more elegantly than from cochineal, boiled with supertartrite potash and sulphate alumine. The process by which it is more commonly prepared is a decoction of Brazil wood with sulphate alumine. The color may be varied by the addition of carbonate potash.

Green.—The acetite copper (verdegris), dissolved in acetous acid, forms an elegant green.

Purple.—A decoction of Brazil wood and logwood affords, with carbonate potash, a permanent purple.

OF BLEACHING.

The operation of bleaching, or whitening, rests on this circumstance, that vegetable colors are

destroyed by the action of air, humidity, and light. For this purpose, the usual practice is to liberate the article intended to be bleached from the adhering grosser particles with which it is colored, which may be effected by boiling it in a pure alkaline lixivium; it is then exposed, with the greatest possible surface, to the direct rays of the sun, and kept constantly moist. The deprivation of color which vegetable matter thus experiences, appears to be owing to the absorption of oxygen, which combines with the coloring principle, and destroys it. And as the oxygenated muriatic acid produces this effect, with so much facility, all other processes must yield to it. Bleaching with this acid may be performed either by immersing the article in a mixture of equal parts of water and liquid oxygenized muriatic acid; or by the application of the acid in a gaseous state, as recommended, p. 58. But a much superior method is to immerse the article intended to be bleached, first in an alkaline solution, as the pure potash, No. 11, and afterwards exposing it to the action of the acid in an aeriform state. The oxymuriatic acid, prepared according to the form, p. 58, is therefore well calculated for this purpose; the alkali in it lessening the adhesion of the vegetable matter, while the coloring principle is destroyed by the action of the acid, itself suffering at the same time decomposition. When the oxygenated mu-

riatic acid is used, it will be advisable to set the vessel in the open air, its smell being exceedingly strong and disagreeable; its vapor produces a violent irritation in the larynx, accompanied with a flow of thickened mucus from the neighbouring glands. This acid should always be kept in the dark, as the action of light brings it to the state of common muriatic acid, by depriving it of part of its oxygen. Besides removing all vegetable colors, it takes out the stain of common writing-ink, but does not affect printers' ink. It is therefore well calculated for cleaning old books and prints. One ounce of red oxide lead dissolved in six ounces of muriatic acid, will be a cheaper preparation, and answers the purpose equally well. Writing that has been effaced by this acid, may be restored by a mixture of prussiate potash and sulphuret of ammonia.

TO TAKE SPOTS OUT OF LINEN, &c.

Grease Spots.—For the removal of these, the spot must be moistened with the solut. pure potash, No. 11, and rubbed between the fingers, or held to the fire, and washed out immediately; the grease being liquified it unites with the alkali, and forms a kind of soap, which may be washed out with plain water; but if the spot to be removed be upon a vegetable color, the application of an alkali will be improper. In this case,

a mixture of equal parts alkohol, No. 26, and sulphuric ether, No. 25, will answer better. Oil of turpentine, and essence of lemon, mixed in equal proportion, will also remove spots of this kind. *See also* Cleaning of Dyed Articles.

Stains from Wine, Fruit, &c.—These may be removed by a little diluted nitric or muriatic acid, but they are more speedily and effectually removed by the oxigenized muriatic acid, p. 58. See also Bleaching, p. 157. If the stain be upon a vegetable ground, that color by these means will also be discharged. See Cleaning Dyed Articles.

Ink Stains and Iron Moulds.—These are best removed by the oxalic acid, No. 27. The muriatic acid, No. 6, and the nitric acid, No. 7, will also remove them. Immediately the acid has dissolved the oxide of iron, which may be known by the disappearance of the spot; it must be rinsed in clean water, otherwise the acid will injure the texture of the cloth.

CLEANING DYED ARTICLES.

In removing stains, &c. from dyed goods, the great point is to remove the stain without injuring the color. Grease spots may be taken out by first moistening them with oil of turpentine, and then applying a little alkohol, No. 26, and afterwards washing it with water. Wine, fruit, lemon juice, vinegar, &c. if dropped upon articles

of this kind always produce a stain, by discharging the color where they fall. In this case the most rational method is to apply some alkali, or alkaline salt, for which the acid has an affinity; but it is to be observed that alkaline salt may destroy the unchanged color, and produce a new spot. For the removal of these spots, without producing this effect, the following preparation will be the best for the purpose: two parts alkohol, No. 26, and one part solut. pure ammonia, No. 12, by being rubbed carefully with this, the spot will disappear.

Paint may be removed by the sulphuric ether, No. 25, or by rubbing it first with oil of turpentine, and afterwards with alkohol, No. 26.

OF COLORS.

Sap Colors are the succulent parts of certain plants, inspissated to a proper consistence; such are gamboge, sap green, &c.

Turnsole is found to be prepared from powdered archil, lichen, or even the greater moss of the oaks, by mixing it with an alkali, and keeping it moist with human urine, until such time as it begins to ferment. It is kept in a state of fermentation until it becomes soft and pulpy; it is then

forced through a hair sieve, formed into lumps, and dried in the shade. This article is also known under the name of litmus.

Carmine.—The method of preparing this beautiful pigment is kept secret from the public. Cochineal is supposed to be the base of it; but none has ever been made in this country to equal the French carmine. With care, it may be made tolerably well by the following process; but there is so much nicety required in the preparation that it seldom or never answers. Take four ounces of the finest cochineal well levigated, and boil it for ten minutes in a gallon of distilled water; while hot, add three drachms of pure sulphate alumine, and boil a minute or two longer; remove it then from the fire, suffer the grosser part of the cochineal to subside, and pour off the supernatant liquor, which, by standing undisturbed, the carmine will be precipitated. If the clear liquor be then decanted, and a solution of muriate tin, No. 16, added, the whole of the remaining coloring matter will be thrown down; but this will be by no means so rich a color as the former.

Lake—is also prepared, or ought to be, from cochineal, with a large portion of alumine for its base; but, on account of the price of cochineal, shavings of Brazil wood are mostly used. A very beautiful lake may be prepared in the following manner: Boil two ounces of very finely powdered

cochineal with one pound of true Brazil shavings, and one pound of sulphate of alumine (alum), in two gallons of water for about two hours, then strain the decoction through a woollen bag, and add very gradually a solution of subcarbonate of potash (salt tartar) until the alum is thoroughly decomposed, which is known by the cessation of action. Care, however, must be taken that the alkali be not in excess; if a little solut. mur. tin, No. 16, be now added, the remaining part of the coloring matter will be precipitated. After being well shaken together, the precipitate may be collected on a filter, formed into balls, and dried with a gentle heat.

Rose Pink is also a species of lake, though of a much commoner kind, having a considerable calcareous base. It is prepared by precipitating a decoction of Brazil wood and sulphate of alumine, with a large proportion of carbonate of lime.

Orange Lake, is the coloring matter of arnatto, precipitated with an aluminous base.

Rouge, an article much employed as a cosmetic, is also a species of lake; it is prepared from the plant carthamus, or bastard saffron. For this purpose, it is first macerated in water to extract its yellow color; it is then digested with a solution of subcarbonate of soda, and the red coloring matter precipitated by citric acid. The precipi-

tate is dried and mixed with talc, or French chalk.

Pink Saucers for dying silks, &c. are merely the red coloring matter of carthamus, prepared according to the foregoing process, and spread upon saucers.

Naples Yellow.—This is a very fine and durable color; it comes from Naples, where it is supposed to be prepared in the following manner: Carbonate lead, twelve ounces; oxide antimony, three ounces; sulphate alumine and muriate ammonia, each one ounce. These are reduced to a fine powder, mixed, and a strong heat applied to keep them for two hours in a state of fusion; the heat is then to be increased to redness for fifteen or twenty minutes. The residuum left in the crucible is Naples yellow.

Dutch Pink, sometimes termed Yellow Pink, is a commoner color, generally prepared by boiling French berries with turmeric root and sulphate alumine, and carrying down the coloring matter with carbonate lime.

King's Yellow, is merely yellow sulphuret of arsenic, generally termed orpiment, purified by sublimation.

Verdigris, forms a beautiful green color; it is a direct acetite of copper, formed by the union of copper with acetous acid. This acetite is prepared in Montpelier, by covering plates of copper

with grape stalks; the preparation thus formed is a subacetite which dissolved in acetous acid, and re-crystallized forms the article termed Distilled Verdigris, a true acetite of copper.

Mineral Green, is formed by precipitating muriate of copper with carbonate of lime.

Green Verditter, is prepared by decomposing a solution of sulphate of copper with carbonate lime.

Blue Verditter may be prepared by decomposing a solution of nitrate of copper with carbonate lime, or by grinding the green verditter upon a color stone, with about five per cent. of quicklime, the green color instantly becomes of a most lively hue.

Smalt is flint glass colored with oxide of cobalt, and reduced to a fine powder.

Bice is smalt more finely levigated.

Ultramarine is the calcined lapis lazuli. It forms a most beautiful color; it is sometimes termed azure.

Prussian Blue, is a compound of iron and prussic acid. See Prussic Acid and Prussiates.

FUMIGATION OF ROOMS.

The means of purifying the contaminated air of rooms, and of counteracting the disagreeable ef-

fluvia that arises from crowded and contagious places, is connected also with a knowledge of chemistry, and is of no little importance to be known in domestic life. For this purpose, various methods have been resorted to, acetous acid, or vinegar, has been regarded from the time of Hippocrates, as a powerful antiseptic, and is to this day by many sprinkled in the chambers of the sick, where epidemic diseases prevail. A more recent practice, and one much more effectual, is the use of the muriatic, or oxygenated muriatic acid gas. For this purpose, sulphuric acid is poured on muriate soda (common salt) placed in a bath of boiling water. The moment they are mixed the person should leave the room, shutting close after him the doors and windows. The oxygenated muriatic acid gas is preferable, where the rooms are inhabited. It is prepared by adding black oxide of manganese to the foregoing articles. Nitrous gas, formed by decomposing nitrate potash (saltpetre) with sulphuric acid, has also been employed with good effect. An antiseptic is sometimes necessary where these means cannot be employed, as in crowded assemblies, theatres, &c. in which case camphor dissolved in the acetous acid, No. 43, will be found not only a grateful but an effectual preventive.

Miscellaneous Domestic Articles.

INSTANTANEOUS LIGHTS.

PHOSPHORIC BOTTLES.

INTRODUCE into a small vial, slightly heated, two or three small pieces of phosphorus, and then stir it about occasionally with a red hot knitting pin, by which means the phosphorus will be slightly oxydated, and will adhere to the sides of the vial, which ignites by the friction of a common sulphur match.

2. Phosphorus mixed in like manner, with about 1-16th sulphur, forms a compound exceedingly inflammable, is sometimes used for bottles of this kind; for which purpose it is spread on the inside of a vial, and ignites on the introduction of a sulphur match.

3. The same combination as the last, rendered tenacious by a small quantity of wax, inflames by taking a small quantity on the end of a match, and rubbing it on a cork.

4. An instantaneous light, without phosphorus, may be made by taking any quantity of oxymuriate of potash, and mixing it with a small quantity of starch, or sugar; the mixture dissolved in spirit, and the end of a common match tipped with it and dried, is immediately inflamed on coming in contact with sulphuric acid. This is by far a better and more safe method of obtaining a light, which, under certain circumstances, is very desirable. Preparations of phosphorus are all extremely dangerous, and should never be employed without the utmost caution.

SEALING-WAX.

Red wax is prepared by dissolving by heat 2lbs. of shellac with eight ounces of yellow rosin; on removing it from the fire, add rectified oil of turpentine, two ounces, and twelve ounces of red sulphuret of mercury (vermilion).

Black Wax.—To the above composition, without the vermilion, add one pound of the finest ivory black. By the same means may be prepared various other colored waxes, by the substitution of different colors.

Green—by a proportion of acetite of copper (verdegris).

Yellow—by sulphate of mercury (turpeth mineral).

Blue—by smalts, &c.

INKS.

Black Writing Ink is a true tanno-gallate of iron; that is, iron in combination with tannin and gallic acid. It appears that it is the red oxide of iron that forms the ink with the galls, but whichever sulphate is employed, when the ink is spread on paper it blackens, from the absorption of oxygen. Iron filings added to ink, lessen its blackness, by abstracting oxygen from the oxide of iron. The following form makes a good black ink: Boil four ounces of logwood an hour in six quarts of water, supplying the water as it wastes; strain the decoction, and add more water to make the liquor up five quarts if it be deficient, while the liquor is still hot, add twenty ounces of bruised Aleppo galls, four ounces of sulphate iron, previously calcined to whiteness, three ounces of brown sugar, six ounces of gum arabic, and half an ounce acetite of copper. Old writings may be revived by sulphuret ammonia, No. 33, or by the prussiate of potash, No. 14, to which a few drops of sulphuric acid, No. 5, have been added. To prepare an ink that cannot be effaced by the oxymuriatic, or any other acid, indigo and oxide of manganese may be added.

Red Ink may be prepared by boiling eight ounces true Brazil shavings, with half an ounce of cochineal, in four pints of acetous acid, for half

an hour, adding to the strained liquor, sulphate alumine four ounces, brown sugar and gum arabic, three ounces of each.

Green Ink may be formed, by adding gum arabic to a solution of acetite of copper, in acetous acid.

Yellow Ink, by adding gum arabic to a decoction of turmeric root, or French berries, with sulphate of alumine.

Indian Ink is made by adding lamp black to a solution of isinglass in water, and evaporating it till it comes to a proper consistence.

Permanent Ink.—A solution of nitrate of silver, No. 34, with a small portion of fine lamp black, forms an ink for writing on linen, which cannot be removed but by cutting out the piece. Linen marked with this preparation, should be previously moistened with a solution of carbonate soda.

Sympathetic Inks are numerous. Writing with nitrate of bismuth, becomes visible when brushed over with water. Solut. sulphate copper, when washed over with solution of ammonia. Tinct. galls, brushed over with sulphate iron. Acetite lead, brushed over with sulphuret ammonia. Muriate cobalt, acetite cobalt, muriate of copper, diluted sulphuric acid, become visible when held to the fire.

CEMENTS

Are a useful domestic article for joining paper, china, glass, &c. &c.

1. Melt together eight parts resin and two wax, to this add an ounce and half of sulphate lime. This composition is an excellent cement for Derbyshire spar, and other stones.

2. A concentrated solution of shell lac in alkohol, added to another solution of isinglass in alkohol, makes an elegant and very durable cement that resists moisture.

3. Clay and oxide of iron, with a small portion of oil, forms a cement that hardens under water.

4. Clay six parts, iron filings one part, made into a tough paste with linseed oil, is an excellent cement for stopping cracks in iron boilers.

GILDING.

Various methods are employed to give the appearance of gold to different metals. The following are the most simple :

GILDING OF SILVER.

1. To the nitro-muriate of gold, No. 46, add sal alemboth (a triple salt, formed of muriate

ammonia and oxymuriate mercury) this solution evaporated to the consistence of oil, is applied to the silver, which it blackens, but which appears gilded after being heated.

GILDING COPPER, BRASS, &c.

2. The metal to be gilt must be first washed with a solution of nitrate mercury, No. 39, which gives a mercurial surface; an amalgam of gold and mercury is then applied, from which the mercury is drawn off by heat; it is brightened by rubbing it with a solution of acidulous tartrite of potash or muriate soda.

GILDING STEEL.

3. Three parts sulphuric ether, No. 25, is added to one part muriate gold, No. 46; the ether immediately separates the gold; into this ethereal solution the steel, for an instant, well polished, is dipt, and then immediately plunged into water; by this means it will be completely covered with gold.

WET GILDING

4. Is performed by merely dipping the article in a solution of muriate gold, No. 46.

SILVERING.

SILVERING COPPER.

1. Two drachms acidulous tartrite of potash, the same quantity of muriate soda, and half a drachm of sulphate alumine, with twenty grains of the argentine precipitate (made by precipitating a solution of silver in nitric acid with slips of copper). This powder rubbed upon copper gives its surface a silvery appearance. It may afterwards be washed off and polished.

2. Equal parts of muriate silver, muriate soda, and acidulous tartrite of potash, form a composition well calculated for silvering the dial-plates of clocks, the scales of barometers, &c. by simply rubbing the powder upon them, and afterwards washing off the saline particles with water.

3. Copper, brass, &c. may be silvered by simply immersing it in the solution of nitrate silver, No. 34.

SILVERING GLOBES.

4. Melt two ounces of bismuth with one ounce of lead, and an ounce of tin. When nearly cold, add two ounces of mercury; this amalgam is to be introduced to the bottom of the globe by means

of a paper funnel, which reaches to the bottom; at a certain temperature it adheres to the glass, by then giving it a circular motion the whole of the globe may be completely silvered. The appearance of these toys are varied by using glass of different colors.

ANIMAL CHEMISTRY,

(From Dr. Reece's Medical Guide.)

EVERY useful art being dependent on chemical science, its cultivation cannot be too strongly enforced as the key of true knowledge and correct information. It is indeed that science which of all others tends to expand the mind. Its subjects are so extensive, as to include the whole of creation, and whatever contributes to the utility or ornament of life, falls within the scope of its investigation. To the contemplative mind, therefore, it affords a field for endless reflection and various inquiry. It lifts the thoughts to that source from whence all creation springs, and in tracing the infinite changes which it is capable of producing as matter, it naturally leads to an attempt to trace the cause from which such changes are produced, and by which they are modified. Thus the existence of a superior power becomes warmly impressed upon the individual engaged in its pursuit. Difficulties occur which the best inform-

ed chemist cannot explain, and which he can alone retrace to an all-powerful and invisible hand, without whose interference he is bewildered in conjecture, and led in a maze of difficulty and perplexities. Every combination shews contrivance and design, and to the person possessing a knowledge of chemistry appears evidently the work of preconceived arrangement, and not the effect of chance or uncertainty. Thus impressed, creation is viewed by him with an admiration superior to that of a casual observer. He traces in every part the wise and unseen hand of the Creator, enduing every atom with certain qualities peculiar and appropriated to itself, and these qualities capable of being altered, improved, and modified, to the various uses and properties of life. But when he descends into the particular branches into which the industry of man has divided this science, he then finds his source of admiration still more complete. If he investigates the business of the manufacturer, he finds that this science is the very basis of his art. It not only furnishes him with the articles with which he is to work, but it enables him to judge of their purity, to detect their adulteration, and to improve their quality. If, again, he enter into the province of the Physician, how essential is this science to the principles and security of the healing art. A mixture of two articles which separately may be

administered with safety, as for instance, quicksilver and the muriatic acid, forms a powerful poison. Without a knowledge of the effects of combinations, how dangerous a task does the physician undertake, and how apt is he, in his desire to remove disease, to do more injury to the human frame than disease itself would produce. Without Chemistry his prescriptions may not be merely nugatory, but, on the contrary, by improper combinations, be made the instrument of pain and death. Even the most active medicines may be rendered inert by their union with other substances, and, aware of this, the physician, ignorant of Chemistry, seldom ventures to prescribe active chemical preparations, although the only remedies likely to prove beneficial. This is a subject Chemistry alone can teach and explain. Thus the most powerful mineral poisons, by the addition of those substances termed sulphurets, are decomposed and rendered harmless in their nature, and vegetable poisons are much counteracted in their effects by the power of acids. But the benefit of this science to the physician, is not limited merely to making him acquainted with the powers of the instruments he employs in the cure of disease; it presents to him a subject still more important, the investigation of the structure and animating principle of the human body, which he finds subject to the same chemical laws with the other organization

of creation. By investigating its economy, he finds that the machine resembles an elaboratory, in which is constantly going on a variety of processes, some simple, others more complicated, but all clearly dependent on chemical attraction. But the view which Chemistry affords of the structure of animals, ought not to be confined to professional admiration and study. It ought to form a subject for the research of every individual who possesses the powers of thought and reflection, who considers for what he is made, and the end of his existence and calling. Dust we are, and to dust we shall return, is the language of sacred writ, and this language cannot be properly understood without a knowledge of Chemistry, shewing the products into which animal matter is reduced, and that earth constitutes the great basis of the whole. In this view then, Medicine, so far as it has yet gone, may be considered in an incipient state. It is a subject of experiments, and these experiments have as yet gone no way in explaining fully the laws of actions of the animal machine, or the cause of the various changes that take place in its economy. Proceeding on these grounds, and considering them the only just and rational ones, for directing to a knowledge of disease, and discovering adequate means of cure, on the true principles of cause and effect, I some years ago published a Treatise of

Physic, founded upon what I termed the Chemistry of the human body. It is the offspring of long experience, serious reflection, and numerous and repeated experiments in an extensive course of practice.

The leading principle with which I set out, and which I believe will be conceded by every philosopher is, that heat is the great exciting cause of animal life. This is proved by the analogy of vegetation, for when diminished to a certain degree, the vegetable creation droops, languishes, and dies. It is by heat the seed is reared into the stem, blossoms, and produces fruit. Nor in animal life is its power less extensive. By heat incubation proceeds, the impregnated ovum is animated, formed into structure, and the animal frame completed in all its functions. What an incomplete existence does the dormouse and other animals, present in winter, when the genial influence of summer no longer animates their frames. View also the difference which the natives of the warm and frigid regions present. See the vivacity, life, and gay manners of the former, compared with the cold inanimate apathy of the latter. The former, warm in their passions and affections, feel alive at every pore; the latter are only roused by strong impulses, and betray marks of torpor, insensibility, and the incomplete energies of life. So much indeed is

the principle of life connected with the possession of it, that we find nature in cold climates has studiously provided for its preservation, in order that the natural heat of animals may not be too rapidly conducted from it by the atmosphere. Thus a thick fleece or coat covers them in the winter season, the thickness of which is in proportion to the degree of cold the climate possesses. In the same manner when this principle exists towards the equator, in the other extreme the woolly thick covering of the same animals is changed for one of thin hair, to allow on the contrary the escape of superabundant heat. The importance then of this principle as identifying itself with life throughout all creation, being evident, the question that naturally arises is, whence is the source from which in the animal machine it is derived and perpetuated.

The brain is the seat of sensation and volition, and by a variety of experiments is clearly concerned in the production of animal heat. If the communication of a part with the brain, be cut off by dividing the principal nerves, the heat is considerably diminished, and by tying the principal artery so as to prevent the flow of blood through it, the same effect will follow, which shew that the evolution of heat is dependent on both the nerves and arterial blood. Analogy also confirms this, and demonstrates that heat is the

effect of decomposition, and consequently is the result of more than one power. This we see exemplified in fire, where oxygen is necessary to combustion. (See Theory of Combustion, p. 33.) In explaining then the origin of animal heat, it may be observed that oxygen, the principle of combustion, is supplied from the atmosphere by the lungs during respiration, and that this oxygen combining with the red particles of the blood, imparts to it, its brightness and florid colour. That the blood thus oxygenated or having received the principle of heat is propelled by the heart through the arterial system to every part of the body. It is in its passage through these vessels it parts with its oxygen, when it is returned again to the heart by another series of vessels termed veins, to be transmitted through the lungs, for the purpose of being reoxygenated. Hence the blood in the veins and arteries exhibit different appearances, that of the latter being bright and florid, while the former is of a dark color, in consequence of the absence of oxygen.

By the brain is produced a subtle fluid * which

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* This subtile fluid may be collected in the animal body by covering the surface with silk. People accustomed to wear silk stockings, particularly gouty subjects, are well aware of this fact; for, on pulling them off in the dark, they may see it

is conducted to every part of the body, by means of branches termed nerves. These filaments of the brain take the course of the arteries or vessels containing the oxygenated blood. By the union which takes place between the subtle or nervous fluid, and the oxygen of the blood, a species of animal combustion is produced; for the nerves, as appendages of the brain, are positively electrified, while the arterial blood, in consequence of the oxygen it holds, is negatively so. Betwixt them, therefore, it is highly probable a disengagement of caloric takes place; the nervous or

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escape in sparks. When the skin is dry, so as not to afford a conducting surface, or when the excitability of the brain is increased, it is often discharged from the brain on the approach of sleep, producing a real electrical shock: this effect, termed starting, we often witness in infants during sleep. Another confirmation of this fact may be drawn from the torpedo and cat. It is probably on account of the brain possessing an electrical power that changes of atmosphere disturb the nervous system. Lightning, by over-stimulating the brain, and destroying its electrical power, often produces sudden death. The vitality of vegetables is no doubt equally dependent on electricity; and the reason why they do not flourish in large towns, is, that the electric matter of that part of the earth is exhausted by the number of the inhabitants. A deficiency of electric fluid in different parts of the world, in consequence of a morbid state of the earth, is probably the cause of some diseases which are attributed to contagion.

Galvanic fluid and the oxygen, thus coming in contact, a general disengagement of heat occurs, and the principle of vitality is thus conveyed to every part. This abundantly accounts for the different degrees of caloric which exists in different parts, according to the size of the nerves and arteries, or according as the apparatus may be interrupted in furnishing its supply by the division or compression of the nerves and arteries. This is strongly proved by what we observe in paralytic limbs, where the circulation is languid from compression of the brain, and the venous blood, contrary to what is usual, displays a very florid appearance, from the circumstance of the nerves not being sufficiently electrified to consume the oxygen of the arterial blood, and of the diminished degree of vitality of the part. In examining the blood contained in the arteries of the fœtus, it presents an appearance unusually dark, when it has not breathed or drawn a supply of oxygen from the atmosphere, and though born alive and not separated from the mother, still it wants the necessary vitality, and generally goes off in convulsions, if there be any impediment to its receiving from the air, an immediate supply of this essential principle. During the fœtal state, its dependence for heat is on the mother, and it possesses of itself no powers to continue the necessary calorification or disengagement of heat, which its system re-

quires for the purpose of its existence. In the same manner, the human worm depends on the body to which it is attached for this vital principle heat, being furnished with no lungs or organ, to contribute a supply itself; and the moment it is removed from the body it expires. Its existence may, however, be continued some time, if it be received into water of the same temperature of the human body.

But independent of the electrical powers of the brain, this complicated organ possesses sentient and intellectual functions. From it the moving and feeling powers emanate by means of the nerves.

From the front of the brain arise two nerves directed to each eye, for the purpose of vision. In the same manner others are given out for distribution to the ears, and produce the sense of hearing. The nostrils are supplied with branches for smell; and the tongue is equally gifted with the same structure, to excite the sensation of taste. The skin, and extremities of the hands and feet, are indebted for their sense of touch to a similar supply. Thus every part of the body receives its sentient powers from the brain, although the organs possess distinct offices. It is by means of the nerves that the sympathy between the brain and the other parts of the body, and different organs, is preserved. For the internal parts of the

system the brain gives out a special nerve or branch, termed the sympathetic nerve. From this branch, arise first, branches to the neck, and from it the cardiac and pulmonary nerves arise, thus supplying the heart and lungs; it next passes through the diaphragm, distributing its filaments in its progress, and gives out branches to the whole abdominal viscera, or organs; thence it is directed to the pelvis and parts of generation. The sympathy existing between the brain and other parts is often peculiar, and varies in its degree, being much greater with certain parts than others. Thus a remarkable degree of sympathy exists betwixt it and the stomach, and whatever disturbs the one, has frequently an immediate influence on the other. In proof it may be instanced, compression of the brain from any cause excites nausea and vomiting, and vice versa, a disordered state of stomach generally produces headache of the most distressing kind. Nor does there exist less sympathy between the genital system and the brain. Hence that state of mind produced by diseases of this part which induces hypochondriasis, madness, and often suicide. The sympathy also in the female betwixt the womb and the stomach is no less worthy of notice. During pregnancy, the stomach participates in every sensation of the former organ: hence sickness, nausea, and vomiting are often the first marks of this condi-

tion. When disease of any kind exists in the womb, the same sympathetic irritation appears to attend its progress, and often forms a clue to the seat of the disease where it is not clearly perceptible. Hence it is highly probable, from the existence of this sympathy between the brain and particular organs in such a high degree that the action of the brain is in a great measure kept up by it. Hence a stimulus applied to the stomach revives the energy of the whole system, and pain produced in the most remote parts of the body will keep up irritation in the brain, so as to suspend the natural operation of sleep. On the same principle, medicines which diminish nervous energy, applied to the stomach produce sleep, and allays pain in a remote part of the body, by quieting the action of the brain. It is in this way we may explain the operation of opium, which acting solely on the stomach, diminishes the sympathy between it and the brain, and of course if the energy of the brain be diminished, the sympathy between it and the other parts of the body will be proportionately lessened. Thus the operation and energy of the brain is increased by stimulating the stomach, and by morbid irritations of any part of the body, and thus sleep is induced and pain allayed, even in a remote part of the body, by diminishing the sympathy between the brain and stomach; for it is too ridiculous to sup-

pose, that the medicine is conveyed to the affected part, in order to its effect taking place.

The brain is also the seat of all the intellectual operations: and hence the mind and body we find reciprocally act on each other. It is a subject of the highest admiration to find the powers of conception, reflexion, and the effect of the passions, all influencing the body, and arising as the operation of an unseen principle embodied in matter, and yet so embodied as not to be capable of detection or apparent visible existence, by the most minute research we can make. The mind, therefore, is only to be traced by its effects, and that these effects may not be carried too far to the injury of the body, or the corporeal part, we find this immaterial principle possessed of a peculiar property, or power, as the guidance of the whole, which under the name of reason, is placed as a guide for our movements and conduct. Such a check is necessary, from the strong influence of the passions in their operation on the system; for instance anger in excess, which constitutes a temporary madness, is capable of the most dreadful consequences. Fear in the other extreme, without this guardian of our conduct, renders us incapable of acting at all. Grief depresses every bodily exertion, and injures the regular operation of the different functions. Nor are even the exhilarating passions less dangerous,

in excess. Joy suddenly excited by unlooked-for events, has produced strong determination to the head and death; and love, when too unhappy, by absorbing every other feeling, has been attended with the same dreadful effects. Reason then, and its modification by judgment, are placed to regulate the passions, and preserve them in due subjection, like the boisterous gales which are apt to overset the bark in its passage through life. By the mind, therefore, the system is most materially affected. By stimulating and rousing the electrical powers of the brain, it naturally produces an increase of heat, while the mild and gratifying passions of hope and confidence acting differently from the others, sooth and guard that inordinate action of the functions of the body, which the others are apt to create. Under disease the state of the passions is therefore a subject of high importance, and requires on the part of the physician as much attention as the state of the body. Nothing tends so much to aggravate the symptoms of a malady, or to keep up the morbid irritation of the system, as the influence of the passions, which are unfortunately too little in the power of the healing art. "Who can administer to a mind diseased," is proverbial, and at least shews the difficulty of the subject.

Connected with the operation of the mind is that peculiar faculty we possess, the indulgence of

sleep; an indulgence necessary both for the mind and body, forming in the language of the Poet, "Tired Nature's sweet restorer to both." By this most remarkable phenomenon which belongs to the animal system, in a moderate degree the mind and the body are benefited. Brutes require less of this indulgence than man, from their mental exertions not being equal. When this faculty is fully enjoyed, and sleep is completely sound, the intellectual functions are entirely suspended. But if the irritability of the brain is increased, the operation of the mind is kept up in consequence of its connexion with this organ, and dreams or vagaries of the imagination arise, which are only the action of the mental powers without the guidance of reason. Hence the absurd and ridiculous ideas they present when awake, though wearing the semblance of rationality during the moments of their occurrence. Of these may be mentioned, holding conversation with the dead, and such other strange imaginations, &c. Morbid irritation of the brain, and irregular or partially suspended action of the intellectual powers, not only give rise to dreams, but is also productive of delirium, of insanity, and of spectral delusions often when awake the brain being only partially affected the person may not be sensible at the time that he is under the influence of disease. Having taken a cursory view of the ani-

mating, vitalizing, and rational principles of the body, I next proceed to consider the means of its nourishment.

The first organic parts subservient to this end are the teeth, which prepare the food for digestion. During the operation of mastication, the aliment is not only divided, but well blended with a fluid principally secreted by the salivary glands, the action of which is kept up by the motion of the jaw during the process of chewing, in consequence of their being situated over the joints of the lower jaw. The food thus prepared is conveyed to the stomach, where it is agitated as in a churn, and mixed with the Gastric juice *, which possesses such high solvent powers as to dissolve bone, and even copper and silver, according to experiments which have lately been made.

The food, thus mixed, forms a slimy mass, termed *chyme*, and as it passes from the stomach into the intestines, its next receptacle, there is separated from it a fluid of a milky appearance, termed chyle, and nature has studiously provided that this chyle, or nourishing part of the food,

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* The juice termed Gastric, is supposed to be a secretion from the stomach; but I am of opinion, that there is no other secretion from the stomach but a slimy matter, to protect its internal surface, and that the fluid termed the Gastric juice is secreted by the pancreas.

should be conveyed to the circulation for the support of the body. The intestines are accordingly furnished with absorbent vessels termed lacteals, the mouths of which are spread every-where over the internal surface, for the purpose of taking up the nutrient part of the digested aliment. The length of the intestines of man is no less than nine times the length of his body, that a great and sufficient surface may be exposed for the action of the absorbent vessels; and this is further increased by numerous folds of the internal coat, which detain also the fluid in its passage for the same wise purpose; thus the intestines, from their situation, their length, their different diameters, thickness, and folds, may be compared not unaptly to the root of a vegetable, which spreads its fibres to a great extent, and in different directions, to draw nourishment from every part of the surrounding soil. This comparison shews the importance of taking proper food, and of its being properly digested or assimulated, for the health and strength of a vegetable depend on the quality of the soil from whence it draws its support. If a weak or unhealthy shrub be removed from a bad to a well manured soil, it will become healthy and strong; the same with the animal body, if his food be good, and the stomach perform its office, the body will be preserved in health, provided he does not indulge in excess. But let the food be ever so good of its

kind, if it be not properly digested, the chyle will be of a bad quality, and not in sufficient quantity, the consequence of which will be, the unassimilated food will undergo decomposition, and carbonic gas will be disengaged and acidity formed; the general health will sooner or later be disturbed, and some local disease will probably ensue.

In its passage through the intestines, the prepared food, received from the stomach, consists of two parts, viz. the chyle already noticed, and of an useless or feculent mass, from which chyle cannot be prepared, constituting what is termed the fœces. The nutrient part, or chyle, taken up by the absorbents, is by them conveyed to the mass of blood, and by the arterial system is distributed to every part of the body for its renovation and support. In order to apply this nourishment, the extremities of the arteries are divided into a set of small canals termed the secerning vessels, and though in examining them no difference appears in their shape, form, and size, from each other, yet it is clear they separate from the blood very different matter or combinations. Thus the secerning vessels that belong to the bones deposit phosphate of lime; those, connected with the glands, supply a peculiar glandular matter; those of the cellular membrane deposit fat; and these different depositions of matter by these vessels can only be

ascribed to chemical affinity; for though all these different matters are secreted from the blood, yet they are not to be discovered in the blood by any experiment or chemical investigation. In the selection of nourishment it may be observed, that animal food, while it increases the muscular strength, is apt to produce an over-fulness of the vessels, and thus occasion heaviness, languor, and lethargy. Vegetable food, on the contrary, though it causes a reduction of strength, tends to calm and quiet the system, and to compose the mind.

The great purport of taking food being to support the body in the mutation which it is constantly undergoing, a supply of aliment is found to be necessary about three times in the space of twenty-four hours. As the chyle furnished by this supply is deposited by the nutrient vessels, the old particles are removed; thus, in the language of Scripture, we may be said, while in life, to be in the midst of death. The set of vessels which take up the old matter, termed absorbents, convey their contents to the mass of blood, from which it is separated by certain organs, and conveyed out of the body. The organs appropriated for this purpose, are the liver, the kidneys, and glands of the intestines. Of these the liver is the principal. By it is secreted the bile, which may be considered as nearly containing the whole feculencies of the blood. It has been asserted, that the bile

tends to promote the digestion of our food; but had the Creator intended such an office for this secretion, it would have been emptied into the organ in which digestion is performed, viz. the stomach, and not into the intestines. But so far from its promoting digestion, it is found that the presence of bile in the stomach never fails to disturb that organ, so as to excite nausea, and often violent vomiting.

The bile, by being emptied into the upper part of the intestines, may be intended to keep up their peristaltic motion. The office of the liver is therefore a most important one in the animal economy. Thus, whatever stimulates this organ, and occasions its more vigorous and complete action in the separation of the bile, (the feculent part of the blood) proves highly useful in the cure of a variety of diseases, by purifying the blood, and keeping up the peristaltic motion of the intestines; hence we may account for the salutary effects of mercury in a great variety of diseases, whose action is chiefly, if not entirely, on the liver.

Next to the liver, as separating useless parts from the blood, may be noticed the kidneys. By this outlet is carried off superfluous water, and the aqueous part of our food which is not appropriated to nourishment, the quantity of which amounts daily to some pounds. Besides the feculent mat-

ter contained in the canal of the intestines from the superfluous parts of the food, there seems to be secreted also from the internal surface of this part, a feculent matter, which constitutes a part of the fœces discharged from the intestines.

The skin may be also an outlet for superfluous matter of the watery kind; but this discharge appears to be principally for the purpose of regulating the temperature of body during the different changes that take place in the atmosphere, and under disease. The vicissitudes of the atmosphere, more than impurity or any chemical combination, are the great causes of disease to the animal frame. Thus health is greater in proportion in large cities, from being less exposed to such vicissitudes, or sudden changes, than in the country. When the temperature of the body rises above the natural standard, by a secretion of perspirable fluid evaporation ensues, and the superabundant caloric is conveyed to the atmosphere. On the contrary, where the body is cool, and the heat below the natural standard, the cuticular discharge is either suppressed, or very trifling.

Besides the secretions, nutrient and excrementitious, there are a great variety of secretions going on in different parts of the body to defend tender surfaces from the action of the atmosphere, and what might produce irritation and mischief; hence the lachrymal glands secrete a fluid (the

tears) for the purpose of lubricating and defending the surface of the eyes. The internal surface of the nostrils pours out a mucus for the protection of the membrane on which depends the sense of smell. The incernal membrane lining the joints is lubricated by a secretion termed synovia. Under disease, the secretion of these parts is often of an acrid quality, excoriating the very surface it is meant to preserve.

In all animals, so strong does nature seem to have implanted the principle of vitality, that they appear capable of conveying it to others, and of forming, if they may be so termed, *Animated Excretions*, peculiar to themselves. This is a most remarkable circumstance. In the human body a variety of worms is generated, peculiar in their structure from any others to be met with out of the body. It has been indeed conjectured that the eggs of such animals may be taken into the stomach with our food and drink, and afterwards evolved; but this supposition falls to the ground, when these animals are traced in every part, as the brain, the liver, and even the flesh, which afford no access for the deposition of eggs. It is highly probable, therefore, that equivocal generation takes place. From these facts we are irresistibly led to draw the humiliating conclusion, that not only are we doomed at last to be the prey of worms, when life, vigour, and animation

are no more, but even at the present moment we are exposed to the same dreadful source of mischief; and while we dance the gay round of pleasure, health, and enjoyment, a worm may be secretly gnawing our vitals, and corroding the nice texture of the brain, or be lodged in our very heart's core.

General and partial Derangements of the Animal Economy, forming Disease.

Having taken a cursory view of the animating and nutritive powers which serve to give, and to support, life and health in the animal frame, I shall proceed to consider the deviations from health which occasionally take place, forming disease. These may be divided into two classes, the *general* and *local*, as they either affect the whole body, or occur in one part.

Of the first, or *general diseases*, the first order is that of increased heat, which admits many divisions.

The simplest of these diseases is common inflammatory fever. Here the blood is over-oxygenated, and the electric or Galvanic powers of the brain being also increased, an excess of calo-

ric is produced. The action of the heart being in consequence quickened, the blood is propelled through the vessels of the brain with greater force, tending to keep up the disturbed state of this organ. The skin becoming dry, caloric continues to accumulate from the want of a conducting surface. From the excess of heat the functions of all the organs are disturbed, and the secretions more or less morbid; hence nausea and squeamishness of stomach, high colored urine, and offensive and dark colored fœces. During this state, if one part of the body be more tender than another, some mischief will probably ensue, particularly if it should continue two or three days, such as inflammation of the lungs, bowels, or brain. This accumulation of heat, it is highly probable, has a considerable influence on the state of the fluids. If coagulation of lymph is a natural effect of heat when applied out of the body, we may presume that the application of the same power will also affect them in the body, though not perhaps to the same degree. Blood drawn in inflammatory fever has certainly a greater consistence, and exhibits more of the buffy coat, than in health.

In this state of body then, how would a chemical physician act, and what treatment would he adopt to restore the condition of health. He would certainly first diminish the quantity of that mat-

ter which attracts oxygen from the atmosphere, viz. the red particles of blood, by extracting blood.* His next object would be to diminish the excitability of the brain, by the application of cold water to the head by means of a napkin. Having thus lessened the supply of oxygen, and diminished the action of the brain, he would next endeavour to carry off the accumulated heat by producing a conducting surface of the whole body, by exciting perspiration. If this be found difficult to be accomplished, he will artificially produce the same surface, by means either of the cold or warm bath, the latter of which is preferable, on account of being more likely to bring on the natural secretion. From the sympathy existing between the brain and the stomach and bowels, he would also empty the intestinal canal, that no irritation might be kept up in it. The secretion of the skin being restored, he would endeavour to keep up the evaporation by enforcing the use of diluent drinks,

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* It has been said, the sulphuret of ammonia diminishes the red particles of blood. If this should stand to fact, it would prove a highly valuable medicine in inflammatory diseases, and would supersede the use of bleeding, which is employed solely for the purpose of extracting or diminishing the red particles. During inflammatory fever, red particles of the blood are conveyed from the system by the urine, forming what is termed a lateritious sediment, which contains iron, and as soon as this takes place, the fever abates.

and for this purpose cold water answers best. Such is the practice that will be found to succeed in simple inflammatory fever. Considering the cause and nature of inflammatory fever, how little is to be expected from the usual prescriptions of physicians, consisting of small doses of antimony, or a saline draught. By irritating the stomach when excessive heat prevails, by wine or tonic medicines, much injury is often done, and the disease aggravated to the highest degree; and when the patient survives, he is indebted to his sound constitution; for, under such remedies, had any part of the system been previously faulty, the patient must have fallen a victim to the treatment.

The next order of this class of general diseases is intermittent fever, the constant and certain cause of which is Marsh Miasmata, or the effluvia produced from a humid soil. The effects of this effluvia are, first to occasion reduction of the vital powers. Hence the extremities become cold; the pulse small and feeble, and the countenance exhibits a ghastly appearance. This state, after continuing for some hours, is succeeded by an opposite one; the heat of the system becoming wonderfully augmented; the pulse full and vigorous, and the vessels of the head overloaded. The duration of this change is limited to some hours, when a copious conducting surface comes on, and

is the means of terminating the fever, which is followed by a languid state of the body.

These phenomena admit an easy explanation. The action of the Marsh Miasmata, in the first instance, depresses the vital principle, and the increased action of the system which ensues, is an effort of nature to regain her lost energies.

To regain health under these circumstances, it is necessary to invigorate the stomach, as the organ which supplies nourishment to the system, and being more connected with the brain than any other. The fever is here evidently a salutary attempt on the part of nature to preserve herself, and resist the morbid cause, but her efforts being proportioned to the degree of debility or deficiency of the vital heat, the temperature of body is considerably raised above its natural standard; hence injury is often produced to some of the organs, particularly the liver, which tends to keep up the effects of the marsh effluvia. This local injury is generally regarded by physicians as the cause instead of the effect of the malady.

When the sentient powers of the brain are disturbed by excessive heat of body, other phenomena are produced. The intellectual functions are disturbed, producing delirium. Symptoms of extreme debility ensue, and this morbid irritation of the nervous system will often continue after the increased heat has subsided. In this state, there

is a disposition in the body to decomposition, and which often partially takes place, producing what is termed mortification. This form of fever has been styled the putrid fever, or typhus. Such fevers are often epidemic, not from the principle of infection, but from a state or condition of the part of the earth on which they occur. Hence the disease sometimes spreads independent of the utmost vigilance to cut off all communication with the infected. Not at the same time that it can be denied that fevers exist of a real contagious nature, from a peculiar matter entering the system, probably by the lungs; for we find the urine will smell strongly of turpentine a few hours after its vapours have been received into the lungs.

In the treatment of such fevers, Chemistry points out the necessity of allaying the morbid excitability of the brain by application of cold water to the head, and to produce a conducting surface of the whole body to carry off the superabundant heat; and for this purpose, sponging the skin with cold vinegar has been found to answer best. It then directs the removal of any irritating matter from the intestines; and lastly, it recommends to keep up a certain cohesion of fibre, from the strong tendency to decomposition; for which purpose astringent matter or tannin,

should be applied to the stomach, as an infusion of rhatany, barks of a similar nature.*

If the blood happens to be impregnated with an excess of muriate of soda, then inflammatory fever will exhibit other phenomena by the appearance of cutaneous inflammation and vesicles, termed erysipelas. Most diseases are aggravated by a super-saline state of the fluids, especially those of secreting surfaces, in consequence of their secretions being strongly impregnated with muriate of soda, as catarrh, cough, fluor albus, gleet, &c. Where this state exists, the urine is strongly impregnated with the muriate of soda.

Besides the forms of fever already described, the ignition of the body is disturbed by contagious matter, giving peculiar forms of disease, and producing different appearances on the skin, as small-pox, measles, chicken-pox, &c. During the increased ignition which attends their progress, a matter of the same nature as the contagion is generated to a considerable extent, and the body rendered secure against any future attack of the complaint. As the production of morbid matter is in proportion to the degree of fever, it is of the

* It is customary to exhibit Port wine in this fever, but the alcohol often disturbs the brain. Dr. Ferriar, of Manchester, asserts, that he has experienced all the good effects from the Rhatany root with sulphuric acid, he ever did from Port wine, without producing the bad effects which often follow the exhibition of the latter.

highest importance in the treatment to diminish it on the first appearance.

During these fevers, as well as the other forms described, the excess of heat, or increased ignition, is very apt to produce mischief in tender organs. Hence we find that eruptive fevers, especially measles, are often followed by organic disease of the lungs termed consumption, particularly where there exists a delicate structure of the absorbent system, or what is termed a scrophulous predisposition. These consequences therefore strongly point out the necessity for using every means of reducing the excess of heat as quickly as possible to the natural standard. But where the natural determination of the disease is, as in these cases, to the skin, the circulation to the surface must not be checked. In small-pox, it has long been the practice to keep the body cool, and experience has proved the utility of this plan; but in measles, the application of cold water to the head may prove useful, but to the surface of the body warm water will be more proper, in order to keep up perspiration, and prevent the determination to the lungs, which is so apt to take place in this peculiar disease.

From these facts it is obvious, that much mischief may be done at all times by the continuance of a high degree of increased ignition, or heat, in tender parts of the system, and such is the for-

mation of the animal structure, that there are few individuals in whom some part is not of a more weak or tender texture than another. By a continued accelerated circulation through such part, accompanied with excessive heat, local derangement will sooner or later take place. Indeed, instances have occurred of the ignition of the body actually running so high, as to produce complete decomposition of the animal structure in a few hours, termed *spontaneous combustion.* The transactions of the Royal Society of London present a remarkable instance of this ignition of body rising to fatal excess. It occurred at Ipswich, and in the Journal de Physique of Paris, many cases, not less remarkable, are recorded. Increased heat then of the body, from its injurious effects, shews the necessity of keeping the system rather below than above the natural standard, and in proof of the advantage of it, we find persons of languid constitutions are generally long-lived, and escape a number of diseases, while the inflammatory habit catching fire on every occasion, or having its heat so easily increased above its natural standard, is the constant victim of disease, and rarely has his life protracted to a distant period.

The next order of diseases that occurs in the arrangement I have adopted, are those of *diminished ignition,* a strong example of which is afforded in dropsy. A chemical physician, review-

ing the phenomena of this disease, would direct his treatment to increase the red particles of blood, that more oxygen may be attracted from the atmosphere. This, it is well known, can be done by the use of the chemical preparations of iron; a metal which analysis of the blood has taught us exists in a certain proportion in those particles. It is by increasing the heat of the system that iron acts as a tonic on the body. The next object in the treatment of this disease will be to increase the general cohesion of fibre, and prevent the tendency to decomposition. This is done by astringents, particularly the Rhatany root and Peruvian bark, and to these means he will next add the use of stimulants, with a view to rouse the action of the brain, and consequently the absorbent system, while the parts affected are supported by rollers, or other mechanical means; and as the outlet of watery mat- is the kidneys, he will stimulate them by the exhibition of the articles termed diuretic.

A morbid state of the sentient powers of the brain forms the next, and a very important class of diseases. The nerves, as they branch out from the brain, have all different offices assigned to them, and hence disease though excited by one and the same cause, exhibits very different phenomena, in consequence of this circumstance. Where the communication between the brain and

the nerves is cut off in any part of their course, either by compression or diseased structure, the nerve loses the power of performing its office. Thus compression of the optic nerve occasions blindness, termed gutta serena, in the same manner a division or morbid state of the nerves of the ears produces deafness.

A morbid degree of irritation of the nerves of the lungs, or muscular fibres of the air vessels, is termed asthma.. The same state, or morbid irritation of the nerves of membranes, or the ligaments of joints, is styled Rheumatism. A similar condition of the nerves of the stomach occasions indigestion; morbid irritation of the kidneys, producing an excessive discharge of urine, is termed diabetes. This state of morbid irritation of the nerves of these different organs, may be either the effect of increased ignition, or excess of vitality, or diminution of heat below the natural standard. It may be here observed, that the nerves of one part of the body are more readily disturbed than others; and this is often transmitted from the parent to the offspring. Hence in a person, whose pulmonary nerves are more delicate and irritable than those of any other part of this system, whatever occasions a general derangement of health, as changes of atmosphere, passions of mind, excesses of any kind, &c. will produce a fit of asthma or affection of these peculiar nerves. In another, where the nerves of the intestines are

in this delicate state, diarrhœa or purging will be produced. In a female, with a morbid irritability of uterine nerves, hysteria shews itself, and the same might be exemplified in a variety of other instances. From this view of the system we can account for one disease suspending the action of another, from its producing a greater degree of irritation, even though that irritation is remote from the seat of the original disease, as by a blister applied to the leg, by fractures, &c.

Thus, to give instances, a blister applied to the leg, has cured a fit of asthma, and that state of mind produced by the influence of charms or mystic remedies, has been found highly beneficial in a great variety of nervous affections. An alarm has often cured a fit of gout, when the patient at the time was unable to move, from the instantaneous and strong effect produced on his mind, in consequence of the terror of fire. Numerous instances of this kind are on record. From the different states of system with which these different affections of the nerves are attended, I have, with a view to simplify their treatment, termed them *super-irritative* and *sub-irritative.**

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* Super-irritation of system is that state in which many diseases can only exist, and when this is removed either by medicine or the debilitating effects of the malady it terminates.

This distinction is of the greatest importance in practice, for the remedies that apply to the one must prove highly injurious when applied to the other. To confirm this by example: In a plethoric female, hysteria is equally a common disease as in women of a different habit. Asafœtida, and other stimulants, if given to the former, cannot fail to aggravate the disease; remedies of an opposite quality being the true antispasmodic suited to the existing morbid circumstances. In rheumatism the distinction now made has been long observed, and hence the terms of acute and chronic, as particularly applied to the two different forms of this disease. The distinction I now contend for is strongly confirmed in its propriety, by considering further the diseases of the young and old. In youth the system shews a more lively degree of irritation, and the blood-vessels being for the most part overloaded, a greater degree of heat is evolved. To apply our knowledge of this state on proper principles to the treatment of disease, we may observe that in white swelling, friction with the warm hand, is decidedly injurious in a young subject, as promoting suppu-

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when it is said spontaneously to cease. So with diseases of diminished irritation, by raising the system to a proper degree, health is restored.

ration and extending organic derangement of structure; but on the contrary, when the arterial system is in a different state, and shews no marks of being overloaded, then the same application of friction will be highly useful, by rousing the powers of the absorbent vessels, and promoting more actively the process of mutation. Hence the age of a patient is a point of the greatest consequence in directing the treatment of a disease as modifying the state of the same malady. To increase our examples, we may observe, that even indigestion, a disease generally attributed to debility and relaxation of stomach, is often an affection of the super-irritative kind. It often occurs in persons who eat much animal food, and indulge in vinous liquors, by which the sanguiferous system becoming overloaded, the brain is compressed, and languor, lassitude, and a sense of seeming weakness are the consequences. By the same cause the brain is disturbed, and the system rendered irritable. Here the usual remedies of stomachics and cordials, of high stimulant powers cannot fail to prove mischievous; while, on the contrary, those means that tend to produce depletion, and unload the system, will restore the body to health.

When the food is not properly digested, fermentation is a process that naturally ensues, occasioning acidity and disengagement of fixed air. The acid thus generated is very powerful,

and is probably of an animal nature, and not merely acetous from the fermentation of vegetable matter, as supposed, for it is evidently attendant equally as much on animal as vegetable diet. As a farther proof of its peculiar nature, when a drachm of magnesia is taken to correct the prevailing acidity of the stomach, it acts with more power than if the same magnesia had been neutralized with the sulphuric acid. There is also here a disengagement of hydrogen in the intestines, which is, I conceive, of an animal nature, being more heavy than common hydrogen. It is probably produced in the intestines, and passes downwards. It may be even ignited by fire. This gas is also found to exist in quantity in the blood.

From morbid irritation of the nerves of muscles arise involuntary contraction of the muscular fibres, termed spasms, which in the large muscles, particularly those of the calf of the leg, are generally very obstinate and painful. In the circular muscles of the intestines, these spasms are most acutely painful, but in point of obstinacy and continued contraction those of the muscles of mastication producing the disease termed lock-jaw, is the most obstinate, proceeding probably from the principal muscle (a short thick one), being *naturally* in a contracted state, in order to keep the jaws together.

In the foregoing view of the system, it has

been observed, the action of the brain regulates its economy, and that the nourishment and mutation of the body is dependent on it, for from it the several organs and vessels derive their primary powers of acting. In cases of local morbid irritation of nerves we may therefore suspect diseased structure or partial derangement will be the consequence: for in the mutation of the body, a process constantly going on, if by this morbid irritation the unison of action be destroyed between the depositing and absorbing vessels, the consequence will be a diminution of bulk, or shrinking of the part, or an increase of bulk. The accumulation or increase will partake of the nature of the part, in the mutation or support of which the vessels were concerned. Thus when the accumulation takes place in the cellular substance, a fatty tumour is formed; if in a bone, the accumulation will consist of bony matter; if in the cuticle, it will constitute a wart; if in the glands, it will exhibit the same degree of firmness and peculiar structure. In the glands of the female breasts, this accumulation is very common, producing that formidable disease termed *cancer*. In explanation of this disease, the nutrient vessels deposit more than the absorbent vessels can carry off, and thus the glandular matter continues to amass, till compression of the nutrient vessels takes place to that degree, that the source of nou-

rishment is cut off from the part, when the latter becomes, as it were, an extraneous body subjected to all the changes of animal matter; and on putrefaction taking place, forming an ulcer, peculiarly fetid and offensive. In the progress of this accumulation the absorbent vessels becoming enlarged, resemble the claws of a crab, from which the disease is named.

In the treatment of this and similar affections, the great object is to increase the action of the absorbent vessels of the part, which cannot be more effectually done than by friction and stimulating plasters. These methods generally succeed in the early period of the disease, before the absorbent vessels are compressed by the accumulated matter. In the process of the mutation of the system, the absorbent vessels act a very important part. From a morbid irritability of these vessels alone arises that peculiar disease termed scrofula, to which persons of delicate structure and morbid sensibility are most subject. Hence it is the disease of genius, of talent, and of those possessed of the finer feelings. Its obstinacy arises from the vessels being constantly in action. Cold bathing seems here so far useful as diminishing the morbid irritability better than any other means. The local mischief which takes place must be treated according to the predominant state of the

system as to plethora or debility, i. e. whether it is of super-irritative or sub-irritative nature.

From the foregoing view of the human body, local diseases may be divided into three classes, viz. *increased* and *diminished ignition ; super-irritation* and *sub-irritation ;* and *diminished irritation.*

The first order of diseases of increased ignition or heat, are those termed inflammation, and here the local increase of ignition is often very great, the part becoming tumefied by the distention of its vessels, and effusion of lymph, the small vessels seem obstructed by the lymph of the blood being thickened in consequence of its increased heat; and this is confirmed by the appearance of the fluid on scarification. In directing his treatment here, a chemical physician would not only unload the vessels of the part, but he would keep up also an evaporation from it by applying to it a simple fluid in a cold state to produce a conducting surface. For this purpose alcohol and ether are the most effectual, as being more rapidly evaporated. The effect of ether indeed depends on its facility to escape, for if it be confined on the part by the hand, instead of conducting off heat it will increase the mischief.

Besides this local treatment, he will also attend to reducing the general increased ignition of the system, by cold applied to the head, by removing general fulness and internal irritation, by purga-

tives, and if the part affected be an important one in the economy, he will reduce the quantity of blood in the system. Local super-ignition or inflammation, exhibits different characters according to different structure of the part it attacks; when it occurs in a secreting surface, there is an increased secretion of the part, which checks its progress to suppuration, when confined by the nerves it is very painful, forming what is termed the gout.

The second order, diseases of local sub-ignition, occur in almost every part of the body, as well as the former, and they arise also from diseased absorbent vessels, and diminished irritation of nerves.

Of the local diseases of morbid irritation those of accumulation have been noticed, but where the secerning extremities of the nutrient vessels do not perform their office, then an opposite state to the former order of diseases takes place, the parts diminishing in size, termed atrophy. When this occurs in the bones, the disease is named rickets, produced in consequence of the phosphate of lime, which gives firmness and solidity to the bones, not being supplied or deposited in their substance in due quantity.

The difference in the appearance and nature of disease therefore arises from the difference of structure of the part in which it occurs. Thus

the morbid irritation that disturbs the mutation of the cuticle will have a different appearance to what takes place where it disturbs the mutation of the Rete Mucosum and the true skin. This difference is strongly instanced in the scalp; if affecting the cuticle only it will exhibit a furfuraceous appearance, or form scald head;—if it extends to the rete mucosum, it will shew the appearance of ring-worm, and if it goes still deeper, it will then constitute a boil, and these different affections will again differ in their appearance as they are attended with a state of super or sub-ignition.

Besides the maladies enumerated, I have in my Nosology introduced a class of diseases from mechanical causes. The first order of this class arises from compression, and comprises apoplexy and dropsy—the former arising from the compression of the brain, the latter from the compression of veins, particularly those of the liver. Jaundice also belongs to this division, from obstruction of the biliary duct by biliary concretions.

The second order arises from laceration, as hemoptoe, from rupture of vessels in the lungs, and hepistaxis from a similar rupture of vessels in the nose.

A third order is formed of loss of natural support, as spina bifida, aneurism, rupture, &c.

Another class comprehends parasitical diseases,

of which there are two divisions, internal and external.

The first comprises the different species of worms, hydatids, stone in the bladder and kidneys, &c.

The latter consists of the itch, lousy disease, Guinea worm, &c.

Some exception may be made to this classification of stone, as giving it animation, and receiving it as a living parasitical production, but it certainly on chemical examination possesses animal properties, and shews at the same time a regular formed structure.

FROM the view thus exhibited of the principle of Animal Life, and the leading phenomena of Disease, the human body forms a complete machine, regulated in its movements and having its existence begun and continued by the action of its calorifying powers, joined with its sentient and intellectual functions. In the treatment then of disease, it is an attention to these combined powers that is to direct our conduct. We have seen, in examining this interesting subject, that the mind, a principle which soars superior to matter, has a leading influence over it, and parti-

cularly over that organ termed the brain, that its power exceeds that of any chemical agent, and that in consequence of this strong regulating influence it possesses, it is highly probable that the efficacy of medicine, and of all such matters as are directed to the cure of disease, depends much on the confidence of the patient, and the impression his mind receives from the flattering prospect held out by their use. Some medicines certainly do much good by the very disgust they excite in the mind, as asafœtida, &c.

In the treatment of chronic diseases, the leading point for attention is the state of the digestive organs. The stomach, like the chemical digester of Papin, is the grand preparer of nourishment, an office on which greatly depends the existence and the health of the system. The importance of this office is particularly pointed out by the analogy of the vegetable kingdom. A shrub, whose branches are withering, stinted, and diseased, recovers as soon as it is transplanted from a bad to a good soil, when it becomes strong, full, and healthy; so in the animal, a proper conversion of food into chyle will have an equal effect. But not only is it necessary that proper nutrition should be supplied for a healthy state, but it is also requisite that the superfluous or feculent parts should be removed from the intestines daily, as they are apt to be

decomposed, by the action of heat, in the intestines, and thus to produce serious injury to the body. So much is Mr. Abernethy impressed with this fact, that there is scarcely a disease which he does not refer to a disordered state of the digestive organs, and to remedy which his treatment is accordingly adapted. One great error in common life may be here noticed as highly prejudicial to health, viz. the custom of indulging in wine or other stimulant liquors during and after dinner. This is not necessary to a healthy action of the stomach, and by accelerating its functions must evidently do harm. Cold water is the best promoter of digestion in youth and middle life, and wine is a cordial that should be only reserved for the weakened powers and incomplete digestion of age. The alkohol of wine appears also to enter the blood, for the air that is expelled from the lungs of a drunkard is impregnated with it. Such a combination must necessarily injure the brain, and sooner or later produce general or local mischief.

In the treatment of diseases again, the age of the patient is a leading point to regulate our conduct in the use of remedies. After the age of fifty, the heyday of life is past. The powers of the system begin to flag, and its former vigour to decay. Morbosity, or deranged structure, in consequence of imperfect mutation, is apt to take

place, as ossification of arteries, thickening of parts, &c. The nervous system is less excitable or susceptible of impressions as it has hitherto displayed. The arterial fulness, or plethora, which distinguishes youth, has now passed to the venous system, where the blood is retarded and accumulates in different parts. At the period when inflammation occurs, and where bleeding may be indispensable as a remedy, it will be necessary to attend with a guarded caution to the quantity and quality of the blood. The same attention must be extended in directing the use of every active medicine to counteract disease.

In diseases where the continued use of mercury is deemed necessary, the stomach and system should be prepared for its exhibition; for if the stomach be disordered, and a morbid acidity generated, purging or diarrhœa will be the consequence. Hence in every chronic disease, before entering upon its cure, some preparatory treatment will be necessary to ensure the success of the means to be adopted.

CHEMICAL ANALYSIS

OF THE

HUMAN BODY.

BRAIN.

IN analyzing the substance of the brain it is found to consist chiefly of a pulpy matter, resembling in its properties albumen, with phosphates of lime, soda, and ammonia.

BONES.

The bones consist chiefly of phosphate and carbonate of lime, with some gelatinous matter. —Fish bones, and the bones of certain quadrupeds, have been found to contain sulphate lime.

SALIVA

Appears to be a combination of muriate soda, phosphates of lime, soda, and ammonia, with a portion of albumen and mucilage.

CHYLE

Has been but little examined; by evaporation it is reduced to a dry mass, which gives out in

distillation an empyreumatic oil and ammonia, leaving a residuum, consisting of carbonaceous matter, muriate soda, and other neutral salts.

MILK

Is composed of sugar, water, oil, albumen, gelatine, muriate soda, muriate potash, sulphur, and phosphate lime.

BILE

Is a compound of water, resinous matter, albumen, soda, phosphate and muriate soda, phosphate lime, saccharine salt, iron, and sulphuretted hydrogen.

BILIARY CALCULI

Contain lime, soda, ammoniacal salt, benzoic acid and a bitter resinous matter.

URINE.

The urine of a healthy person always contains phosphates of lime and magnesia, carbonate lime, phosphoric, carbonic, uric, and benzoic acids; gelatine, albumen, muriate and phosphate soda; phosphate and muriate ammonia; sulphur, resin, urea.

URINARY CALCULI

Generally consist of urate ammonia, though sometime of phosphates of ammonia and magnesia.

PERSPIRABLE MATTER

Appears to be principally water, in which lymph and carbonic acid are dissolved.

BLOOD.

This important fluid separates spontaneously on standing, into two different parts;—the white part is termed serum, the other coloured part the crassamentum. The former is composed of gelatine, albumen, sulphur, muriate and carbonate soda, with phosphates of soda and lime. The crassamentum consists of albumen, phosphates of iron and soda.

MUSCLES

Consist of fibre, gelatine, albumen, and extract with phosphates of ammonia, lime and soda, and carbonate lime.

THE SKIN

Consists of three parts, the epidermis, mucous membrane, and the cutis. The epidermis contains albumen, gelatine, and phosphate lime; the two latter contain the same as the epidermis, with the addition of fibre, and a larger portion of gelatinous matter.

NAILS.

The nails, horns, and hoofs of animals con-

sist principally of a kind of coagulated albumen.

HAIR

Yields nitrogen, sulphur, carbonate ammonia, and charcoal.

FAT

Is a combination of the phosphate of lime, with sebacic acid.

TEARS

Contain water, soda, muriate and phosphate soda, phosphate lime, and mucilage.

MUCUS OF THE NOSE

Is constituted of the same principles as the tears, excepting a larger portion of mucilage. Its greater viscidity is owing probably to its being more exposed to the air, and to the absorption of oxygen.

WAX OF THE EAR

Consists of phosphate lime, soda, albumen, and oil.

SEMINAL FLUID

Contains mucilage, water, soda, and phosphate of lime.

INTESTINAL GAS.

Where the digestion is good, seldom any other than the carbonic acid is formed; but a slow and irregular digestion generally gives rise to the formation of azotic, sulphuretted and carbonated hydrogen.

THE

CHEMICAL CHEST.

THE Chemical Chest, though furnished with a collection of the most useful Tests, yet as there are a number of others which are occasionally required in the investigation of particular bodies, we shall subjoin a kind of

CHEMICAL DIRECTORY,

that the student may be enabled to prepare them himself. Chemical re-agents are for the most part combinations of an acid with some salifiable base, as an earth, alkali, or metallic oxide;—and as we are acquainted with 32 acids and 57 salifiable bases, and many of the acids capable of uniting with two, and even three bases at the same time, it forms a class of binary, trituary, and quaternery combinations beyond calculation. But as the properties of many of them have never been investigated, we shall confine our attention more immediately to those that come under the subject

of experiment. With respect to the preparation of the several acids (as the present work is intended for the experimentalist) we shall leave them to the practical chemist, without further observation than pointing out their constituent principles.

ACIDS IN GENERAL

Are combinations of oxygen with some acidifiable base; but as many of them are capable of uniting with two different proportions of oxygen, they have been divided into two different classes, and distinguished by the terminating *ous* and *ic*: thus sulphur, with a small dose of oxygen, forms the sulphurous acid; with a larger portion the sulphuric—with phosphorus, the phosphorous acid, the phosphoric acid, &c. These acids, when united to salifiable bases, form salts, possessed of different properties, and which are also distinguished by the termination of their nominative case. When formed of the acids ending in *ic*, the salts are known by the termination *ate*, as the sulphuric acid forms sulphates. When an acid ending in *ous* is employed, the salt formed has its termination *ite*, as the sulphureous acid forms sulphites, the phosphorous acid forms phosphites, &c. &c.

SULPHURIC ACID AND SULPHATES.

Sulphur, when combined to its maximum with oxygen, is metaphorically termed sulphuric acid;

its specific gravity is near double that of water, being near 1.9—from its running in striæ like oil, and having an oleaginous feel, it has been vulgarly called Oil of Vitriol. When mixed with water, a considerable degree of heat is immediately evolved. If brought in contact with vegetable or animal matter, it is partially decomposed, and carbon is formed; hence the property it has of burning the fingers or the clothes, if dropped upon them. When united to earths, alkalies, and metallic oxides, sulphates are formed, all of which are decomposable by barytes, are insoluble in alkohol, and with ignited charcoal, are converted into sulphuret.

SULPHATE POTASH

May be formed by neutralizing carbonate of potash with dilute sulphuric acid, evaporating the solution, and suffering it to crystallize.

SULPHATE SODA

Is prepared in the same manner as the foregoing, using carbonate of soda in lieu of carbonate potash.

SULPHATE AMMONIA.

By neutralizing carbonate of ammonia with diluted sulphuric acid, and proceeding as before.

SULPHATE MAGNESIA

Is prepared in the same manner as the foregoing, by using carbonate of magnesia.

SULPHATE ALUMINE.

The alum of commerce is not unfrequently known by this name, but this is a trinary compound of sulphuric acid, albumen, and soda. To prepare this, it is necessary to precipitate a solution of alum with carbonate potash, and to redissolve the precipitate in dilute sulphuric acid.

SULPHATE LIME

Is precipitated on adding sulphuric acid to any solution of lime.

SULPHATE BARYTES

Is also precipitated, on the addition of sulphuric acid to any barytic solution.

SULPHATE LEAD

May be obtained by pouring dilute sulphuric acid into a solution of acetite lead.

SULPHATE SILVER

May be obtained by adding sulphuric acid to a solution of nitrate silver.

Sulphate copper, iron, zinc, mercury, bismuth, manganese, nickel, and cobalt, each of these may

be obtained by digesting the respective metals in diluted sulphuric acid in a gentle heat, and afterwards evaporating the solution till a pellicle appears at the surface, then remove them from the fire, and suffer them to crystallize.

SULPHUREOUS ACID AND SULPHITES.

This acid, like ammonia, naturally exists in an oxide state, though nearly absorbed by water. The sulphur in this preparation is imperfectly oxygenated. It has the property of destroying vegetable colors, and on this account is employed in bleaching. It has but little action on metallic substances, and has little or no attraction for earths and alkalies. The combination of this acid with salifiable bases form salts, termed sulphites, the properties of these are not considerable; they yield sulphur by heat, which converts them into sulphates, as also do the nitric and oxymuriatic acids.

Sulphite lime, potash, soda, ammonia, and barytes, may be obtained by passing a stream of sulphureous acid gas through a solution of the base employed, and subsequent evaporation and crystallization.

SULPHATE MAGNESIA

Is produced by saturating carbonate magnesia with sulphureous acid.

The other sulphites are so little known, that nothing can be said upon them.

MURIATIC ACID AND MURIATES.

The basis of the muriatic acid is unknown. It exists in the gaseous state under the name of muriatic acid gas. Liquid muriatic acid is water impregnated with this gas. It is extremely pungent; it emits white fumes on coming into contact with a moist atmosphere, which is the gas condensing again by combining with the humidity of the air. It is unalterable by any combustible body known. It has the property of decomposing the sulphureous, carbonate, and phosphoric acids, from all their combinations. With different bases it forms salts, termed muriates, which are all decomposed by the sulphuric acid, and yield oxygenated muriatic acid gas, by the addition of nitric acid. They are also decomposed by solutions of silver, and are volatilizable at high temperatures.

MURIATE POTASH

Is procured by perfectly neutralizing the carbonate potash with muriatic acid.

MURIATE SODA

Is prepared in a similar manner, using carbonate soda in place of potash. This is our com-

mon table salt, resulting from the combination of two caustic substances.

MURIATE AMMONIA.

This salt is prepared by a peculiar process for commercial purposes, but it may be obtained by dissolving carbonate ammonia in muriatic acid, to perfect saturation, evaporating the solution, and suffering it to crystallize.

Muriatic barytes, lime, strontia, magnesia, &c. are all prepared by the same means, merely dissolving the carbonates of these substances into muriatic acid, and subsequent evaporation and crystallization.

MURIATE SILVER

May be obtained by pouring muriatic acid into a nitric solution of silver.

MURIATE LEAD

Is formed by a similar process, that of adding muriatic acid to a solution of nitrate lead; the muriate lead instantly precipitates.

MURIATE IRON, TIN, ZINC, ARSENIC, NICKEL, COPPER, AND MERCURY.

Either of these may be prepared by dissolving the respective metal, or its oxide, to saturation in muriatic acid, after the action ceases filter the solution, evaporate and crystallize.

MURIATE GOLD, BISMUTH, ANTIMONY, AND COBALT.

For the preparation of either of these it is necessary the acid should be more oxygenated, which is readily accomplished by the addition of a small quantity of the nitric acid, which constitutes with the muriatic acid the article termed

NITRO-MURIATIC ACID, OR AQUA REGIA.

The oxygen of which quits its own base, and unites with that of the muriatic acid, which then rapidly oxydates the metal, and afterwards dissolves it.

OXYGENATED MURIATIC ACID.

This acid, and the article last mentioned, aqua regia, are similar preparations; with this difference, the latter holds nitrous gas in solution. This acid has the singular property of destroying vegetable colors, and on this account it constitutes the major part of the different kinds of bleaching liquids that are sold. It has a suffocating odour, and a styptic bitter taste. Its action on the metals presents phenomena extremely curious; the metal is first oxydated by the superabundant quantity of oxygen, which the de-oxidated acid afterwards dissolves. This acid, with different bases, forms salts, termed oxymuriates, which are possessed of very singular properties; when

heated they yield oxygen, and become converted into muriates. They detonate loudly by friction with inflammable bodies, as also by the effusion of sulphuric acid.

OYMURIATE SODA, POTASH, AND LIME,

Are prepared with rather more difficulty than many of the foregoing. They are produced by passing a current of oxygenated muriatic acid gas through a solution of soda, potash, or lime. When the saturation is complete, the salt separates in crystals.

OXYGENATED MURIATE OF TIN

Is formed by passing this gas through a solution of muriate of tin.

OXYGENATED MURIATE LEAD

Is prepared in a similar manner.

OXYGENATED MURIATE OF COPPER, AND OXYGENATED MURIATE OF IRON

Are best prepared by dissolving the oxide of copper, or the red oxide of iron, in cold muriatic acid.

NITRIC ACID AND NITRATES.

This acid is a compound of nitrogen and oxygen; but so slightly united to its base, as to be

decomposed by almost any thing into which it comes in contact. It is rapidly decomposed by all the metals, gold and platina excepted. By yielding its oxygen so readily, it causes the sulphureous and phosphorous acid to pass to the state of sulphuric and phosphoric acids. On the same principle it inflames oils, charcoal, &c.; when mixed with water, heat is evolved. It tinges the skin yellow, which does not disappear till the epidermis wears off. With salifiable bases it forms salts, termed nitrates; these salts detonate and inflame combustible bodies at high temperatures. On this property of nitrates gunpowder is founded, which consists of five parts nitrate potash, one of charcoal, and one sulphur; they afford oxygen and nitrogen gases at high temperatures, and yield nitrous acid by the addition of the sulphuric acid.

NITRATE POTASH.

This salt is prepared by neutralizing carbonate potash with dilute nitric acid, evaporating the solution, and permitting it to crystallize. This salt detonated with an equal quantity of acidulous tartrite potash, forms the article called White Flux; when detonated with twice its weight of acidulous tartrite of potash, it forms what is termed Black Flux. Three parts of nitrate potash, one sulphur, and one saw-dust, forms the article Powder of Fusion.

NITRATE SODA

Is formed in the same manner as nitrate potash, using carbonate soda.

NITRATE AMMONIA

May be prepared in like manner, taking care in the evaporation not too much heat is applied. This salt is chiefly employed for obtaining the gaseous oxide of azote, which, when heated, has the singular property of exciting highly pleasurable sensations, great exhilaration, and an irresistible propensity to laughter.

NITRATE MAGNESIA, BARYTES, AND STRONTIA,

Are all of them prepared by neutralizing either of the carbonates in dilute nitric acid.

NITRATE SILVER, MERCURY, IRON, COPPER, LIME, NICKEL, BISMUTH, COBALT, LEAD, TIN, AND ZINC.

These may be prepared by first mechanically dividing the metal, and adding it by degrees to nitric acid, diluted with an equal quantity of water, a violent effervescence takes place, nitrous acid is disengaged, and the metal is dissolved, which afterwards may be crystallized by evaporation.

NITROUS ACID AND NITRITES.

It has long been a received opinion, that the nitrous acid was less oxygenated than the nitric, but the recent experiments of Davy and Thompson satisfactorily prove that they are precisely the same acid, with this difference, the latter is weaker, and holds nitrous gas in solution. This is very easily exemplified by exposing nitrous acid to heat, the nitrous gas is disengaged, and what remains is in every respect the same as the nitric acid. The salts formed by the combinations of these two acids bearing so strong an analogy to each other, what has been advanced respecting the property of nitrates, equally applies to those which in the new nomenclature are termed nitrites.

ACETOUS ACID AND ACETITES.

In conformity with modern classification, we give to this acid the termination *ous*, though it is the opinion of many that it is more strictly the acetic, the quantity of oxygen in both acids being proportionally the same. On account of its being formed by the fermentation of wine, it has been called vinegar; though in this state it is far from pure acetous acid, but may be rendered so by distillation. It acts on most of the metallic substances, though its affinity for them, and also the

earths and alkalies, is inferior to the preceding acids.

The results of such combinations are termed Acetites, all of which are decomposeable by heat and sulphuric acid, the acetic acid being for the most part disengaged.

ACETITE POTASH

Is prepared by neutralizing the carbonate of potash with pure acetous acid, and by a gentle heat evaporating the solution for crystallization. In like manner is prepared Acetite Soda, Lime, Barytes, Strontia, and magnesia, by taking their respective carbonates.

ACETITE AMMONIA

Is a solution of carbonate ammonia in acetous acid. It is not crystallizable. This preparation is known by the name of Mindercrus's Spirit.

ACETITE SILVER

Is the product of double elective affinity; by mixing together a solution of acetite potash with nitrate silver, the acetite silver precipitates.

ACETITE MERCURY

May be obtained by the same process as the last, using nitrate mercury and acetite potash.

The acetite mercury precipitated in this preparation, is the base of the famous Keasley's pills.

ACETITE IRON, LEAD, AND NICKEL,

Are formed by direct combinations of the metals with acetous acid, subsequent evaporation and crystallization.

THE ACETITE ZINC

Is best formed by mixing a solution of acetite lead with sulphate zinc; the sulphate lead precipitates, and the acetite zinc remains in solution, which may be crystallized by evaporation.

ACETIC ACID.

The difference between this acid and the acetous, is, in the latter containing a larger portion of carbon. Its odour is extremely pungent and penetrating. It is so powerful when concentrated as to corrode the skin. It readily dissolves camphor, and forms the pharmaceutical preparation termed Camphorated Acetic Acid. This aromatised with some essential oil, has long been sold under the title of Henry's Aromatic Vinegar. From the analogy between the two acids there is no distinction made between their salts. The acetites are frequently termed acetates, and vice versa.

CARBONIC ACIDS AND CARBONATES.

This acid at all temperatures exists in a gaseous state, and is generally termed Carbonic Acid Gas, Fixed Air, Mephitic Air, &c. It is unfit for respiration and combustion. Its energy as an acid is but feeble, though distinct and certain. It forms with earths alkalies and metallic oxides, compounds termed carbonates, all of which are rapidly decomposed with effervescence on the addition of sulphuric, nitric, or muriatic acids. Some of them are insoluble in water, but become soluble by an excess of carbonic acid.

CARBONATE POTASH.

Potash exists in two distinct states of combination with carbonic acid, that of a subcarbonate and a perfect neutral carbonate. The former is merely a lixivium of common potash, evaporated and crystallized. The latter is sometimes prepared by passing a current of carbonic acid gas through a solution of the subcarbonate. Though the process more generally employed is that of digesting it for some time upon carbonate ammonias with a heat of about 180, which drives off the ammonia, and leaves the carbonic acid in combination with the solution, which affords crystals by careful evaporation. This salt has been termed Aerated Kali, Acidulated Kali, Supercarbonated Kali, &c.

CARBONATE SODA.

What has been said upon carbonate potash applies precisely to this, there being no other difference in the preparation than employing subcarbonate soda in place of subcarbonate potash. This salt is now much used for making the Alkaline Mephitic Water. It is known frequently by the term Aerated Soda, Supercarbonated Natron, &c.

CARBONATE MAGNESIA.

A solution of subcarbonate of potash, added to a solution of sulphate magnesia, precipitates the carbonate of magnesia in a white insoluble state.

CARBONATE AMMONIA

Is procured by distilling two parts dry carbonate lime with one nitrate ammonia.

CARBONATE OF SILVER, MERCURY, COPPER, IRON, TIN, LEAD, NICKEL, AND ZINC,

Are all prepared by the same means. The metal is first mechanically divided by rasping or pulverization, and then thrown by degrees into diluted nitric acid. After the effervescence ceases, add to the solution carbonate potash till no further precipitate ensues. The precipitate should then be well washed and carefully dried.

PHOSPHORIC ACID AND PHOSPHATES.

This acid is a combination of phosphorus combined to its maximum with oxygen. It is capable of existing in a dry state, and though it possesses a strong attraction for moisture, it has a powerful affinity for the earths and alkalies, though but little influence on metallic substances, its combinations with these bodies are termed phosphates, which run into glass when urged by the blowpipe, and are soluble in nitric acid, from which they may be precipitated by lime water.

PHOSPHATE SODA.

This, like most of the preceding alkaline salts, may be obtained by neutralizing the carbonate of soda with phosphoric acid. This salt has been introduced into practice as a tasteless aperient.

Phosphate ammonia, potash, magnesia, barytes, and strontia, are all prepared in a similar manner.

Posphate mercury, copper, iron, lead, bismuth, tin, and zinc, may each of them be prepared by adding a solution of phosphate soda to a solution of the respective metal in dilute nitric acid. The phosphate precipitates, which must be edulcerated and carefully dried.

PHOSPHOROUS ACID.

This acid is composed of phosphorus, with a smaller portion of oxygen. It has an unpleasant

taste and an alliaceous disagreeable odour. It is volatilized when warmed, and the vapour visible in the dark. With alkaline, terrene, and metallic bases it forms salts, termed Phosphites. They yield, when heated in the air, a phosphorescent flame, and detonate with oxygenated muriates. The properties of phosphorus have been but little investigated. The phosphate potash, soda, ammonia, and lime, may be prepared by neutralizing the respective carbonates with phosphorous acid; and proceed as directed before.

ARSENIC ACID AND ARSENIATES.

Arsenic acid is arsenic fully oxygenated. It exists in a solid state, but is not crystallizable; is decomposable by all combustible bodies, and many metallic oxides. It unites with different bases, forming salts termed Arseniates, which are known by being precipitated from their solutions of a yellow color by hydro-sulphurets, and on being decomposed when heated with charcoal.

ARSENIATE POTASH

Is formed by neutralizing carbonate of potash with arsenic acid.

Arseniate Soda, Arseniate Ammonia, Arseniate Magnesia, and Arseniate Barytes, are all prepared by dissolving to perfect saturation their carbonates in a solution of arsenic acid.

ARSENIATE LIME

May be obtained by pouring into lime-water arsenic acid; the arseniate of lime precipitates.

ARSENIATE COPPER

Is precipitated by mixing a solution of arseniate potash with one of sulphate of copper. This precipitate is termed Scheele's Green.

Arseniate Iron, Silver, and Mercury, are prepared by a similar process, that of dropping arsenic acid, or arseniate of potash, into a solution of the respective metal.

ARSENIOUS ACID

Is known in commerce by the name of White Arsenic. It has a subacid taste, and, when heated, is volatilized in the form of a white vapour, which has a strong alliaceous smell. The nitrates and oxygenated muriates are decomposed by it, and with the phosphoric and boracic acids it fuses into glass. It forms with different bases, salts termed Arsenites. They are all uncrystallizable, and are decomposed by heat and the stronger acids. They were formerly termed Livers of Arsenic, but they have not been sufficiently examined to give them a detailed description.

OXALIC ACID AND OXALATES.

Oxalic acid, or acid of sugar, exists in a crys-

talline form, of a very acid taste, is distinguishable by its strong attraction for lime, and by its remaining unaltered on exposure to the air. It contains more oxygen than other vegetable acid. It is soluble in water, and in the muriatic and acetous acids. With salifiable bases it forms salts, termed oxalates, all of which are decomposed by lime-water, and the precipitate soluble in acetous acid.

OXALATE POTASH

Is prepared by neutralizing carbonate of potash with a solution of oxalic acid.

OXALATE AMMONIA

Is formed in a similar manner by neutralizing carbonate ammonia with oxalic acid, evaporating it till a pellicle appears, and suffering it to crystallize.

OXALATE SODA AND BARYTES

Are formed by the same means.

OXALATE LIME

Is precipitated by adding oxalic acid to lime-water.

OXALATE STRONTIA

Instantly precipitates on adding oxalate potash to nitrate strontia.

BORACIC ACID AND BORATES.

The base of Boracic Acid, or Acid of Borax, is at present unknown. It is separated from the subborate of soda by the superior affinity of sulphuric acid. Its crystals are white and brilliant, soft, and unctuous to the feel, and possesses but little acidity, though distinct and certain. It gives a green color to the flame of alkohol, in which it is extremely soluble. When urged by the blow-pipe, it fuses into glass. Its union with different bases forms salts, termed Borates, which are not altered by any combustible body, but are decomposed by the sulphuric, nitric, and muriatic acids, and at a boiling temperature deposit on cooling crystals of boracic acid.

BORATE POTASH, SODA, AND AMMONIA.

The salts are formed by neutralizing their carbonates with a concentrated solution of boracic acid. In the same manner is formed Borate Magnesia.

BORATE LIME

Is formed by adding a solution of boracic acid to lime-water.

BORATE ALUMINE

Separates on adding a solution of borate soda to one of sulphate of alumine.

BORATE COPPER

Is formed by mingling a solution of sulphate of copper with a solution of subborate soda. The new compound precipitates.

BORATE SILVER, MERCURY, IRON, ZINC, NICKEL, AND LEAD.

Each of these are obtained by adding to a solution sublimate of soda (borax) a solution of either of these metals in nitric or muriatic acid.

SUCCINIC ACID AND SUCCINATES.

Succinic Acid, or Acid of Amber, exists in a crystallized state, and remains permanent in the air. Its taste is strongly acid, is very soluble in boiling water and hot alkohol; on being exposed to heat it suffers decomposition; with salifiable bases succinates are formed, the properties of which are but little known. The alkaline succinates are sometimes employed in the analysis of mineral waters, such as the

SUCCINATE POTASH, SODA, LIME, AND AMMONIA.

Either of these may be formed extemporaneously in the same manner as directed for sulphates, &c. by neutralizing their carbonates with succinic acid

PRUSSIC ACID AND PRUSSIATES.

This acid takes its name from the article known in commerce by the name of Prussian Blue. In smell it resembles the peach tree flowers, or bitter almonds. It has no action on metallic substances, though it unites readily with most of their oxids, forming very insoluble compounds. It possesses a natural tendency to form triple compounds with alkalies and metallic oxids; in which state it decomposes all metallic salts; hence it becomes a most useful agent in analytical chemistry. The salts formed with this acid are termed Prussiates; they are all decomposed by acids, light, and caloric. Most of the metallic prussiates are insoluble, though none of them have been much examined; greater attention has been paid to the triple prussiates, as the

PRUSSIATE POTASH AND IRON,

Which may be prepared by boiling Prussian blue in a solution of pure potash until such time as its color ceases to be discharged. Prussiate of potash and iron has the property of precipitating all metallic substances. For a more certain method of preparing this important salt, see Henry's Elements of Chemistry.

PRUSSIATE LIME AND IRON

Is prepared by a similar process, that of boiling Prussian blue in fine powder in lime-water.

PRUSSIATE BARYTES AND IRON.

By adding finely powdered prussiate iron (Prussian Blue) to boiling barytic water, till its color ceases to be discharged.

PRUSSIATE STRONTIA AND IRON

May be formed by the same process, using strontia in lieu of barytes.

PRUSSIATE IRON.

This pigment, termed Prussian Blue, is prepared by igniting three parts of dried blood with two carbonate potash, make a lixivium of this by repeated affusions of water, and add to it a solution of one part sulphate iron and two alum: a beautiful green precipitate falls down, which is known by the name of Prussian Green. If this precipitate be washed with diluted muriatic acid, it assumes a beautiful blue color.

CITRIC ACID AND CITRATES,

Is found in a variety of acid fruits, as the lemon, the grape, the orange, &c. It exists in the form of crystals, which are not altered by exposure to the

atmosphere. It dissolves readily in water, to which it imparts an acid flavour, exceedingly pleasant, much more so than the expressed lemon juice; on which account it is now much employed for domestic purposes. The sulphuric and nitric acids convert it into the acetous acid. It acts powerfully on many metallic substances. At a red heat it is decomposed into carbonic and carbonated hydrogen gases, leaving behind a portion of oxide of carbon. It readily unites with alkaline, terrene, and metallic substances, forming salts termed Citrates, which the sulphuric, nitric, and muriatic acids have the power of decomposing; as also have the tartaric and oxalic acids.

CITRATE LIME

Is prepared by neutralizing carbonate lime with citric acid; the citrate of lime precipitates; from this precipitate citric acid is generally prepared by decomposition with sulphuric acid, which separates the lime in the form of an insoluble sulphate, while the acid is set at liberty, and may be crystallized by careful evaporation.

CITRATE POTASH, SODA, AMMONIA, AND MAGNESIA,

May be prepared by neutralizing their respective carbonates with citric acid.

CITRATE BARYTES AND CITRATE STRONTIA,

Are prepared by adding a solution of citric acid to a solution of nitrate of strontia or barytes.

CITRATE SILVER, MERCURY, IRON, ZINC, AND LEAD,

Are formed by dissolving their oxides into citric acid; subsequent evaporation and crystallization.

TARTAREOUS ACID AND TARTRITES.

This acid is generally found in a state of combination with lime. Its crystals are permanent in the air, and soluble in water. It has a greater attraction for lime than the nitric, muriatic, phosphoric, or acetous acids. It has a strong tendency to combine with potash, with which it unites in two different proportions, forming salts possessed of different properties; in one proportion it forms a deliquescent salt, Tartrite Potash, and when the acid predominates, a salt is formed of difficult solubility, Supertartrite Potash. The tartrites are decomposable by heat and sulphuric acid, and many of them capable of triple combination.

TARTRITE POTASH, SODA, AND AMMONIA,

Like most of the foregoing alkaline salts, are prepared by the neutralization of their respective carbonates with tartareous acid.

TARTRITE POTASH AND SODA

Is formed by neutralizing the excess of acid in supertartrite of potash with subcarbonate of soda.

TARTRITE POTASH AND LIME.

By adding tartrite potash to lime water.

TARTRITE POTASH, BARYTES, AND TARTRITE POTASH AND STRONTIA,

Are produced by the same means, that of dropping tartrite potash into their respective solutions.

TARTRITE POTASH AND AMMONIA

Is prepared in the same manner as tartrite potash and soda, using carbonate of ammonia in place of soda.

TARTRITE SILVER, MERCURY, LEAD, AND BISMUTH,

Are prepared by dropping a solution of either of these metals in nitric acid, into a solution of supertartrite potash.

TARTRITE IRON AND TARTRITE COPPER,

May be obtained by decomposing sulphate of iron, or sulphate of copper, with a solution of acidulous tartrite of potash.

GALLIC ACID AND GALLATES.

This acid is the produce of the gall nut, though it constitutes a part of all vegetable astringents. When pure, it is in the form of white brilliant crystals, of an astringent sour taste, soluble in boiling water and alkohol. It readily unites with metallic oxides, and precipitates them from their solutions; gold, silver, and copper, of a brown colour; mercury, orange; bismuth, yellow; lead, white; and iron, black; this last combination is the basis of inks and black dyes. With different bases it forms salts, termed Gallates, which have never been examined.

FLUORIC ACID AND FLUATES.

This acid constitutes a part of the Derbyshire spar, in which it is united with lime in the form of fluate of zinc. In smell it resembles the muriatic acid. It has little or no action on metallic substances, but dissolves many of their oxides. The most singular property of fluoric acid is its power of dissolving glass. Salts formed with this acid are termed Fluates, which become phosphorescent on being exposed to a strong heat, and are decomposable by sulphuric acid.

FLUATE SODA, AMMONIA, POTASH AND MAGNESIA

Are prepared by neutralizing their carbonates with fluoric acid.

FLUATE BARYTES AND STRONTIA,

Are precipitated by adding fluoric acid to a solution of muriate barytes or strontia.

FLUATE SILEX.

By suffering fluoric acid to remain in contact with silex, this salt will be formed.

FLUATE MERCURY, TIN, AND SILVER.

These are precipitated on the addition of fluate of potash to a nitric solution of these metals.

FLUATE IRON

May be obtained by dissolving red oxide of iron in fluoric acid.

BENZOIC ACID AND BENZOATES.

This acid has long been known under the title of Flowers of Benzoin, from a resin of the same name, wherein it exists in considerable quantity. Its crystals are colorless, and extremely light; permanent in the air, and nearly insoluble in cold water, but dissolves readily in hot water and alkohol, also in the sulphuric nitric, and acetic acids; from which it may be again separated by the addi-

tion of water. The salts formed with this acid are termed Benzoates. Their properties have been but little examined. The oxides formed by this acid are for the most part soluble in water.

BENZOATE SODA.

This salt may be obtained by neutralizing carbonate soda with benzoic acid, or by boiling the carbonate in water with the resin called benzoin, the acid quitting the resin unites to the soda, and forms benzoate soda : from this salt the benzoic acid is mostly obtained, by decomposing it with muriatic or sulphuric acid.

BENZOATE LIME, POTASH, SODA, AMMONIA, BARYTES, ALUMINE, AND MAGNESIA,

May each of them be prepared in a similar manner, taking the carbonate of each and neutralizing it with benzoic acid, evaporating the solution, and suffering it to crystallize.

MALIC ACID AND MALATES.

Malic acid is mostly obtained from the juice of unripe apples, from whence it derives its name. This acid always exists in a fluid state, from its being incapable of crystallization. Nitric acid converts it into oxalic acid. It precipitates mercury, silver, and lead from their solu-

tions in the nitric acid. The salts formed by the combination of this acid with different bases, are termed Malates, the properties of which are not sufficiently known for us to take notice of them. Scheele is the only person that has at all examined them. The alkaline and terrene metals may be obtained in the same manner as most of the preceding salts, by neutralizing their carbonates with malic acid.

MOLYBDIC ACID AND MOLYBDATES.

This metallic acid exists in the form of a yellowish powder, of a slightly acid taste, and a specific gravity nearly four times heavier than water. Sulphuric and muriatic acid dissolves it by the assistance of heat, forming a blue solution. This acid is very little known, nor are the molybdates that are formed by its combinations with different bases.

SUPER-MOLYBDATE POTASH

Is the only salt that has been examined with any kind of accuracy. It is formed by detonating one part of sulphuret of molybdene with three of nitrate potash, dissolving the mass in water, and precipitating the molybdate potash by the addition of sulphuric acid.

THE CAMPHORIC ACID AND CAMPHORATES, THE CHROMIC ACID AND CHROMATES, THE LACTIC ACID AND LACTATES.

The above, as well as several other recent discovered acids, as the Ammotic, the Bombic, Columbic, Laccic, Mucous, Saccholactic, Sebacic, Lubecic, &c. &c. are scarcely known, excepting by their names, it would therefore be superfluous in a work of this kind to give them a detailed description. Those who may be desirous of a further account we refer to Henry's Elements of Chemistry, or Aiken's Dictionary of Chemistry.

CHEMICAL TABLE.

The following Table shews the quantity of Acids and Bases required for their neutralization.

Bases.			Acids.	
525	Parts of Alumine	re-quire	Fluoric	427
615	Magnesia		Carbonic	577
672	Ammonia		Sebaccic	706
793	Lime		Muriatic	712
859	Soda		Oxalic	755
1329	Strontia		Phosphoric	979
1605	Potash		Formic	988
2222	Barytes		Sulphuric	1000
			Succinic	1209
			Nitric	1405
			Acetic	1480
			Citric	1682
			Tartareous	1694

This Table is very useful in pointing out the quantity of acid a base requires to neutralize it: for instance, 615 parts of magnesia, take 427 parts of fluoric acid, or 577 carbonic acid to neutralize it. It also readily points out the quantity of a base the acids require to neutralize them, as 427 parts of fluoric take 1605 parts of potash to produce a neutral salt, the fluate of potash.

3

The following Table, published by Mr. Kirwan, shews the quantity of real acid taken up by alkalies and earths:

100 Parts.	Sulphuric	Nitric.	Muriatic.	Carbonic.
Potass . .	82,48	84,96	56,30	105
Soda . . .	127,68	135,71	73,41	66,80
Ammonia	383,80	247,82	171	Variable
Barytes .	50	56	31,80	282
Strontian	72,41	85,56	46	43,20
Lime. . .	143	179,50	84,49	81,81
Magnesia	172,64	210	111,35	200
Alumine .	150,90	. . . . .	. . . . .	335

Table of the quantity of alkalies and earths, one hundred parts of the sulphuric, nitric, muriatic, and carbonic acids require for saturation, by Mr. Kirwan:

100 Parts.	Potass.	Soda.	Ammo.	Baryt.	Stron.	Lime.	Magn.
Sulphuric	121,48	78,32	26,05	200	138	70	57,92
Nitric......	117,70	73,03	40,35	178,12	116,86	55,70	47,64
Muriatic .	177,60	136,20	58,48	314,46	2 6,21	118,30	898
Carbonic .	95,10	149,60	. . . .	354,50	231	122	50

The following Table of Chemical Affinities, exhibiting the comparative force of affinity between the different bodies, is very useful, as pointing out the decomposition which will take place on their admixture.

	Sulphuric Acid.	Nitrous Acid.	Muriatic Acid.	Acetous Acid.	Carbonic Acid.
Barytes	65	62	36	29	14
Potash	62	58	32	26	9
Soda	58	50	28	25	8
Lime	54	44	20	19	12
Ammonia	46	38	14	20	4
Magnesia	50	40	16	17	6
Argil	40	36	10	15	2

GASES IN GENERAL.

WITH the Gases are produced some of the most striking, and indeed the most important phenomena in Experimental Chemistry. We shall therefore commence our List of Experiments by pointing out the manner of obtaining them.

By the term Gas, is meant a permanent, elastic, aeriform fluid, incapable of being condensed into a liquid or solid state, by any degree of cold hitherto known. They are combinations of some particular substance rendered aeriform by caloric; the bases of some of them may be exhibited in an uncombined state, while others are not producible by art.

For the collection of gases particular instruments are necessary, and which are termed the

PNEUMATIC APPARATUS.

Which consists of a wooden trough, with a shelf fixed horizontally about three inches below the brim; its dimensions to be one-third the width of the trough. In this shelf are three or

four holes, over which the receivers are placed invertedly, previously filled with water. The retort being filled with the materials for furnishing the gas, a tube is fixed to it, which reaches under the hole in the shelf in the pneumatic trough; as the gas is formed it displaces the water, and which it continues to do until the receiver is filled with the aerial fluid. This receiver must then be taken off, and another put in its place; care being taken to keep the mouth of the filled receiver under water, which can easily be done by placing it on the unperforated part of the shelf. Vide plate.

EXP. 1.

OXYGEN GAS.

Put about four ounces of black oxid of manganese into an iron or stone retort, and pour on it two ounces of sulphuric acid; place the retort in a sand heat, and oxygen gas will be generated, which may be received in the manner mentioned for the collection of gas. This gas may be obtained from all the metallic oxids, from the leaves of vegetables, nitrate of potash, &c.

EXP. 2.

Into a receiver filled with oxygen gas, and confined over mercury, introduce a piece of phosphorus through the quicksilver, which will immediately rise to the surface; then set fire to the

phosphorus, by means of a piece of red hot wire, which will burn vividly, a considerable quantity of light and caloric will be disengaged, and phosphoric acid will be formed.

EXP. 3.

Fill a receiver with oxygen gas, and introduce into it a small piece of sulphur, which, on being ignited with a piece of red hot wire, will burn with a vivid blue flame, when the combustion ceases, and the fumes disappear, the water over which the combustion takes place will be found sensibly acidulated. This is the method generally pursued for making sulphureous acid.

EXP. 4.

Fill a receiver, to which a cork has been previously fitted, with oxygen gas; fasten to the cork a piece of iron wire in a spiral form, fixing to its end a piece of thread or tinder, which, on being lighted and plunged into the gas, the iron will burn inconceivably vivid, throwing out a number of brilliant sparks, ascending in a spiral direction. On examination, the iron will be found to be oxydated and experience an increase in weight.

EXP. 5.

Into a receiver, filled with oxygen gas, introduce a piece of ignited charcoal, a number of scin-

tillating sparks will be thrown out in every direction, and the whole assume a beautiful sun-like body in appearance.

EXP. 6.

Introduce a lighted taper into a vessel filled with oxygen gas, it burns with great splendor. If the taper is blown out, and introduced again while the snuff remains red hot, it constantly rekindles with a slight explosion, and burns as before.

EXP. 7.

A mixture of one part boracic acid, and two charcoal, burns with a brilliant green flame in oxygen gas.

EXP. 8.

One part nitrate barytes, No. 23, and four powdered charcoal, burn in oxygen gas with a brilliant yellow flame.

EXP. 9.

A piece of cotton dipped in alkohol, No. 26, or oil of turpentine, burns beautifully brilliant in oxygen gas.

EXP. 10.

Camphor previously lighted, and introduced into oxygen gas, burns also extremely vivid.

EXP. 11.

Resin, elastic gum, or any combustible body, will burn in this gas; the phenomena attending are extremely vivid and beautiful.

EXP. 12.

HYDROGEN GAS.

This gas, from its great inflammability, has been termed inflammable air, but from its being always produced by the decomposition of water, it has by the moderns received the name hydrogen, implying a generator of water. To obtain this gas, put some filings of iron and zinc into a retort, or any other convenient vessel, and pour over it some diluted sulphuric acid, the water will be rapidly decomposed, the hydrogen uniting with the disengaged caloric, forming hydrogen gas, which may be received in the usual way.

EXP. 13.

Fill a bladder with hydrogen gas, and adapt a stop cork, or a piece of tobacco pipe to it; by applying a lighted candle to the end of the pipe, and pressing the bladder, the gas will burn with a lambent blue flame; a proof of the inflammability of this gas.

EXP. 14.

Introduce a lighted candle into a receiver filled

with this gas, it will be instantly extinguished; a proof that although the hydrogen gas is inflammable, incapable of itself of supporting combustion.

EXP. 15.

Fill a bladder with this gas, and adapt to it a tobacco pipe; by dipping the bowl in a lather of soap, and gently pressing it, soap bubbles will be formed, which will ascend rapidly in the air, and if touched with a lighted taper they instantly take fire. This experiment also demonstrates the inflammability of hydrogen, and also proves its extreme levity; on which principle is founded aerostation, or the theory of balloons, which are invariably filled with this gas.

EXP. 16.

It has been shewn that this gas is unfit for combustion; if a bird, or any other animal, is put into it, it is instantly thrown into convulsions, and soon expires. A proof that it is also unfit for respiration.

EXP. 17.

Fill a bladder, to which a tobacco-pipe has been fixed, with a mixture of this gas and oxygen gas. Form soap bubbles with it as in Exp. 15, which, on being touched with an ignited body as they, ascend, will be inflamed with a smart explosion,

and water will be formed. It has been conjectured that these atmospheric phenomena, as thunder and lightning, which are generally followed by rain, are produced by the combustion of these two gasses in the air, fired by an electric spark.

EXP. 18.

Put into a vial the ingredients for furnishing hydrogen, and fix a tobacco-pipe through the cork, by applying a lighted taper to the end of the pipe the liberated gas will burn beautifully, as long as any is formed. This is termed the philosophical candle.

EXP. 19.

Take a vial, with a tobacco-pipe fixed through the cork, as in the last experiment, and put into the vial about two drachms æther, No. 25, by placing it in a vessel of hot water, the hydrogen of the æther will be vaporized, and will burn a considerable time on being touched with a lighted body.

EXP. 20.

Set fire to a little æther, No. 25, or alkohol, No. 26, in a bell glass of atmospheric air; as soon as the oxygen in the air is consumed the flame will be extinguished, and on the sides of the bell glass will be found water trickling down;

a ready mode of forming water by its constituent parts, oxygen and hydrogen.

EXP. 21.

CARBONIC ACID GAS.

Upon one ounce of marble grossly powdered, pour about two ounces diluted sulphuric acid, and carbonic acid gas will be liberated.

EXP. 22.

Pass a stream of carbonic acid gas from a bladder, through lime, barytic or strontia water, and it will immediately become turpid: and carbonate of lime, barytes, or strontia, will be precipitated.

EXP. 23.

Fill three upright jars, one with oxygen gas, the second with carbonic acid gas, and the other with atmospheric air, a candle introduced into the latter will burn as usual; taken from thence, and put into the carbonic acid gas, it will be instantly extinguished; but on being immersed into the oxygen, while the wick remains red, it will be rekindled, and burn vividly.

EXP. 24.

NITROUS GAS.

Put into a retort a few ounces of powdered nitrate potash, and pour over it some sulphuric

acid; by applying the heat of a lamp, nitrous gas may be obtained.

EXP. 25.

Mix one part of nitrous gas with four of hydrogen gas; this mixture set on fire burns with a green flame.

EXP. 26.

Introduce into nitrous gas a piece of ignited charcoal, a vivid inflammation follows.

EXP. 27.

SULPHURETTED HYDROGEN GAS.

Upon sulphuret of iron, in a proper vessel, pour sulphuric acid, and sulphuretted hydrogen gas will be disengaged.

EXP. 28.

Three parts of sulphuretted hydrogen gas, mixed with two of nitrous gas, burns on being ignited with a yellowish green flame.

EXP. 29.

Invert in a basin of water, a jar filled with sulphuretted hydrogen gas, an absorption will take place, and the water will be found slightly acidulated. This is the only instance we have of an acid being formed without the presence of oxygen.

EXP. 30.

Mix equal parts of sulphuretted hydrogen gas, and apply a lighted taper, a smart detonation ensues, and the gases disappear.

EXP. 31.

AMMONIACAL GAS.

Add to two parts of quick lime, one of muriate ammonia; on the application of heat, this gas will be liberated in abundance.

EXP. 32.

Convey some ammoniacal gas into a vessel containing carbonic acid gas; the instant they come in contact, absorption takes place, and solid carbonate of ammonia will be found lining the inside of the jar.

EXP. 33.

PHOSPHORATED HYDROGEN GAS.

Add to the ingredients for making hydrogen gas, a few small pieces of phosphorus, and phosphorated hydrogen gas will be generated.

EXP. 34.

Place the beak of the retort containing the articles for making the foregoing gas, in a vessel of water; as the gas arises it takes fire, the moment it comes in contact with atmospheric air, accompanied with a slight explosion.

EXP. 35.

Into a receiver filled with oxygen gas, convey a bottle or two of phosphorated hydrogen gas. The moment they come in contact, a brilliant flash of fire takes place, accompanied with a loud report. Great caution is necessary in performing this experiment, as the vessel is apt to be blown in pieces.

EXP. 36.

SULPHUREOUS ACID GAS.

Upon a small quantity of mercury in a retort, pour some sulphuric acid; on the application of heat, sulphureous acid gas will be disengaged.

EXP. 37.

Mix sulphureous acid gas with ammoniacal gas, over mercury, a beautiful white cloud will be formed by their combination; heat liberated, and both gases assume a solid state.

EXP. 38.

OXYGENIZED MURIATIC ACID GAS.

Put into a retort one part of black oxid of manganese, and pour over it four parts strong muriatic acid, No. 6, and oxygenized muriatic acid gas will be liberated in abundance.

EXP. 39.

Into a vessel filled with the above gas, intro-

duce a sprig of mint, a rose, or the leaves of any vegetable, and their colours will speedily be destroyed.

EXP. 40.

A lighted taper immersed in a jar of this gas, burns with a red colour, and a very brilliant flame. This gas, on the other hand, is fatal to animal life.

EXP. 41.

Oxygenized muriatic acid gas inflames metallic substances; into a jar filled with it, let fall a thin leaf of copper (Dutch gold) which will take fire before it reaches the bottom of the receiver, and burn with a green flame.

EXP. 42.

Into a bell glass, filled with this gas, throw in small quantities at a time, some filings of copper, tin, or antimony, they will be instantly inflamed, and appear like a shower of fire.

EXP. 43.

Dry, upon blotting paper, a small piece of phosphorus, and then introduce it into a jar of oxygenated muriatic acid gas, it kindles instantly, and burns with a brilliant green flame.

EXP. 44.

Melt a piece of roll sulphur, and introduce it in a state of perfect liquidity into a jar filled with this gas, the sulphur immediately takes fire, and burns rapidly.

EXP. 45.

Put into a wine glass one part of oxymuriate potash, No. 31, and pour on it a little sulphuric acid, a violent action ensues, and oxygenated muriatic acid gas is evolved. If a drop or two of æther, No. 25, or alkohol, No. 26, be suffered to fall into this gas, an ascension takes place with a crackling noise.

EXP. 46.

Put one part of oxymuriate potash, No. 31, with three or four of water, and half a part of oil of olives, into a glass cylinder, and add to it four parts of sulphuric acid, a violent action immediately takes place, and a multitude of scintillating sparks are thrown out, exhibiting a beautiful phenomenon; on adding an additional quantity of oxymuriate potash and sulphuric acid, the whole takes fire, and burns with a dense yellow flame.

EXP. 47.

Into a tumbler filled three parts full with water, let fall one part phosphorus, and two oxygenized

muriate potash, No. 31; on adding gradually to this mixture four parts sulphuric acid, the phosphorus takes fire, and burns vividly at the bottom of the water, while bubbles of gas arise and take fire, as they come in contact with the circumambient air.

EXP. 48.

GAZEOUS OXID OF NITROGEN.

This singular substance is obtained by exposing nitrate ammonia, to a heat of about 400 Fahrenheit; care being taken not to let the heat exceed 500. After the gas is generated, it is required to stand about six hours over water, when it becomes fit for experiment.

EXP. 49.

Gazeous oxid of nitrogen, when mixed with atmospheric air, and breathed, which may be done by means of a bladder and stop cork, the nostrils being closed. It excites every fibre to action, rouses the faculties of the mind, and induces a state of great exhilaration, and an irresistible propensity to laughter. A rapid flow of vivid ideas and unusual fitness for muscular exertion, in some respects resembling those attendant on the pleasantest period of intoxication, without any subsequent languor.

EXP. 50.

Pour a small quantity of sulphuric acid, No. 5;

mixed with a few drops of nitrid acid, No. 7, into a vessel containing about a table-spoonful of oil of turpentine; the moment they come in contact flame will be produced. Care must be taken in performing this experiment.

EXP. 51.

Dissolve an ounce sulphate soda in about two ounces of boiling water, and while hot, pour it into a vial, and cork it close. In this state it will never crystallize, but on removing the cork it instantly crystallizes. This experiment tends to shew that atmospheric air is necessary to crystallization.

EXP. 52.

Into a wine glass put about half an ounce of mercury, and pour over it half an ounce of nitric acid, No. 7, diluted with an equal quantity of water. The acid will be decomposed with astonishing rapidity, an effervescence indescribably vivid and pleasing will go on during the whole time the acid is operating on the metal. The solution passes through different colours, and ultimately becomes perfectly limpid; the result is a nitrate of mercury.

EXP. 53.

Take the solution formed in the last experiment, and add to it a little more mercury, and ap-

ply to it the heat of a lamp, so as to evaporate a part of the water. On removing it from the lamp, needle-shaped crystals will be seen crossing each other in every possible direction. This is an instance of the formation of a metallic salt.

EXP. 54.

Dissolve two drachms of mercury, without heat, in six drachms of nitric acid, No. 7, diluted with an equal quantity of water; dissolve also with heat the same quantity of mercury in a similar quantity of the same acid, then add to each of these colourless solutions a little pure ammonia, No. 12. In the one case, the metal will be precipitated of a black, in the other of a white powder, shewing the difference of the colour of metallic oxids, according to their degree of oxidizement.

EXP. 55.

Into a solution of carbonate soda, No. 8, pour as long as any effervescence ensues, muriatic acid, by gentle evaporation the mixture may be crystallized. This is a mild salt, resulting from two caustic substances.

EXP. 56.

Take carbonate ammonia, and pour over muriatic acid as long as effervescence arises from these two pungent substances; a mild salt, perfectly inodorous, is formed.

EXP. 57.

Mix a solution of muriate lime with a solution of pure potash, No. 11, from these colourless liquids a solid mass will be produced.

EXP. 58.

Take the solid mass formed in the last experiment, and add to it nitric acid; the whole immediately becomes transparent.

EXP. 59.

Mix a solution of oxymuriate mercury with some lime-water; from these colourless fluids a deep orange-coloured mixture is formed.

EXP. 60.

To the orange-coloured mixture formed in the last experiment, add a little diluted sulphuric acid, and the whole is again rendered transparent.

EXP. 61.

Add to a tumbler of water, a few drops of a solution of sulphate copper, not sufficient to tinge it; to this add a little pure ammonia; from the mixture of these two colourless fluids a deep blue solution is formed.

EXP. 62.

Add to a tumbler of water a few drops of a so-

lution of sulphate of iron, No. 13, and add to this a little prussiate of potash and iron, No. 14, a deep blue precipitate is formed—Prussian blue.

EXP. 63.

Proceed as in the last experiment, and add in the place of prussiate potash a few drops of tincture of galls, and a black precipitate will be formed.

EXP. 64.

To a tumbler of water, containing a small quantity of a solution of acetite of lead, No. 18, add a few drops of sulphuret of ammonia, No. 33, the whole instantly becomes entirely black.

EXP. 65.

Put a little tinct. litmus, into a wine glass, and add to it a few drops of diluted sulphuric acid, its purple colour will be changed to a bright red; if to this is added a little potash, No. 11 , its purple colour will be restored.

EXP. 66.

To an infusion of roses add a little potash, No. 11, it is instantly converted to green; but if a little muriatic acid, No. 6, is added, it is as speedily changed to red.

EXP. 67.

Add to an infusion of turmeric, a few drops of

potash, No. 11, its yellow colour is converted into brown, but which is restored again by muriatic acid, No. 6.

EXP. 68.

Into a wine glass, containing a colourless solution of sulphate copper, add a few drops of prussiate potash, and a reddish brown precipitate is formed, being a prussiate of copper.

EXP. 69.

Pour a little tinct. litmus, into a glass, containing some diluted sulphate indigo, by the mixture of these two blue solutions a red one is formed.

EXP. 70.

To the black mixture formed, Exp. 63, add a little diluted sulphuric acid, and it will be rendered perfectly transparent; by the addition of an alkali, its black colour may be restored.

EXP. 71.

Take the blue solution formed, Exp. 61, and add to it a little diluted sulphuric acid, its limpidity is instantly restored, but may be rendered blue again by the addition of ammonia.

EXP. 72.

Take a transparent solution of sulphate magnesia, No. 11, and add to it a solution of pure potash, No. 11, the mixture becomes nearly solid.

EXP. 73.

Triturate in a mortar equal parts of acetite lead and sulphate of zinc; these two solid substances will become fluid.

EXP. 74.

Pour into three different glasses some infusion of red cabbage; to one add a solution of alum, to another a solution of potash, No. 11, and to the third, a few drops muriatic acid, No. 6, the first will assume a purple, the second a bright green, and the third a beautiful crimson colour. Three different colours are here produced from the same vegetable infusion, by the mere addition of three colourless fluids.

EXP. 75.

If muriatic acid is suspected in any liquid, it may be detected by holding over it a single drop of pure ammonia, No. 12, which will cause a dense white smoke to arise.

EXP. 76.

In like manner, ammonia may be detected in any fluid, by holding over it a drop of muriatic acid, which will produce very evident white fumes.

EXP. 77.

Pour into lime-water some oxalate ammonia, No. 19, a white precipitate of oxalate of lime immediately will be formed.

EXP. 78.

Take the white substance formed in Exp. 72, and add to it a little sulphuric acid, No. 5, it instantly becomes limpid.

EXP. 79.

Mix carbonate of lime (common chalk) with some water, a milky mixture will be formed, and on standing the chalk again falls to the bottom, but by adding a few drops of muriatic acid, No. 6, an effervescence takes place, and the whole is rendered transparent. The first is a mere mechanical mixture, the latter a complete chemical compound.

EXP. 80.

Prepare two glasses, into one drop a little sulphuric acid, No. 5, and into the other a little solution of barytes; on mixing these two colourless fluids, a white precipitate of sulphate of barytes will be produced.

EXP. 81.

Proceed as in the last, using nitrate lead in the place of the barytic solution, and a white precipitate of sulphate of lead will be produced.

EXP. 82.

Mix a solution of sulphate iron, No. 13, with a solution of carbonate soda, No. 8, a greenish

precipitate will fall down, which is carbonate iron. It turns reddish brown on exposure to the air.

EXP. 83.

To a little solution of nitrate silver, No. 34, add a little muriatic acid, No. 6, or sulphuric acid, No. 5, a white precipitate will instantly be formed, which will be either muriate or sulphate of silver.

EXP. 84.

Triturate in a mortar a little solid carbonate ammonia and sulphate copper; a very deep blue compound is produced, which is the Ferrum Ammoniacum of the College.

EXP. 85.

Digest in a sand heat, an ounce of mercury, with about double the quantity of sulphuric acid, No. 5; by urging the heat, a solid white mass is formed, which, on being thrown into boiling water, instantly becomes a bright yellow. This is termed turpeth mineral.

EXP. 86.

Triturate in a mortar an ounce of mercury with two of flowers of sulphur, till they become intensely black; if this black compound is heated with a solution of pure potash, No. 11, it becomes of a

most beautiful red. This is the method in which vermilion is prepared in the humid way.

EXP. 87.

On some iron filings pour some strong sulphuric acid, No. 5, no action will take place, but a violent one on the addition of water, and the solution by evaporation will yield fine green crystals of sulphate iron.

EXP. 88.

Upon one ounce of powdered lump sugar in a Florence flask, pour six ounces of nitric acid, No. 7, apply a gentle heat, and a prodigious quantity of nitrous air will be disengaged, and the solution, on cooling, will form crystals of oxalic acid.

EXP. 89.

Boil a little sulphuret of antimony (crude antimony) with some pure potash, No. 11, and strain the decoction while hot, which will be transparent. Add to this some sulphuric acid, No. 5, or muriatic acid, No. 6, and a deep orange precipitate will be produced, which is Kermes Mineral.

EXP. 90.

Take the crystals formed in Exp. 52, and place them in a sand heat, in an open glass vessel, or China cup, they will first become yellow, and on

urging the heat a glittering red powder will be formed, vulgarly termed Red Precipitate.

EXP. 91.

Take the solution formed in Exp. 52, and add to it a solution of muriate of soda, common salt, an abundant precipitate will be formed, which, when sufficiently edulcerated, forms the submuriate of mercury, or calomel.

EXP. 92.

Take the white precipitate formed in the last experiment, and add to it a few drops of pure ammonia, No. 12, or a little lime-water, which will turn it entirely black. This is a ready mode of proving the goodness of calomel.

EXP. 93.

Triturate in a mortar some oxymuriate of mercury and water, little or no solution takes place; but by adding an equal quantity of muriate ammonia, No. 37, both instantly dissolve; add to this solution a little potash, and a white powder will be produced, which is the white precipitate of mercury.

EXP. 94.

Dissolve a little tartrite antimony, (emetic tartar) in water, and add to it a little sulphuret am-

monia, No. 33, a dark orange-coloured precipitate is formed, the Golden Sulphur Antimony.

EXP. 95.

Suspend in a solution of acetite lead, No. 18, a small piece of zinc, by means of a piece of brass wire, the solution will be decomposed, the lead will attach itself to the zinc, and shoot out in ramifications forming a kind of metallic tree.

EXP. 96.

Drop upon a bright piece of copper a little solution of nitrate silver, in a short time a metallic vegetation will take place, branching out in very pleasing forms, and the copper on being rubbed will be completely silvered.

EXP. 97.

Put into a tumbler of water a small piece of phosphuret of lime, No. 35, and in a short time flashes of fire will dart from the surface of the water.

EXP. 98.

With a little phosphuret of lime, No. 35, mix some oxymuriate potash, No. 31, put it into a tumbler of water, then introduce, by means of a tobacco-pipe, a small quantity of sulphuric acid, No. 5, to the ingredients at the bottom, which

will take fire, and burn at the bottom of the water as well as at the surface.

EXP. 99.

To a few bits of phosphorus, No. 30, in a Florence flask, add about a quarter of a pint of water, and apply the heat of a lamp, balls of fire will be seen to issue from the water, resembling an artificial fire-work.

EXP. 100.

Fix in a quill a small piece of phosphorus, No. 30, and write with it upon paper; the writing in the dark appears beautifully luminous.

EXP. 101.

If any part of the body be rubbed with phosphuretted æther, in a dark room, that part will appear as though it were on fire, without producing any dangerous effect or sensation of heat.

EXP. 102.

Triturate three parts of oxygenated muriate potash, No. 31, with one sulphur; the mixture detonates violently; if a little of it is wrapt in paper, and struck with an anvil, the same effect is produced.

EXP. 103.

Into nitric acid, No. 7, diluted with an equal

quantity of water, put some strips or filings of copper, a most violent action takes place, nitrous gas is disengaged, and the metal is dissolved, which affords on evaporation blue crystals of nitrate of copper.

EXP. 104.

Take the crystals formed in the last experiment, or nitrate copper, No. 36 in the Chest, powder it and spread it on a piece of tin foil, add one drop of water, and roll it up quickly, wrapping the whole in a piece of paper; in the course of a few seconds combustion takes place, and the tin is inflamed.

EXP. 105.

Mix some sugar and oxymuriate potash, No. 31, together, and place it on a tile; if to this a single drop of sulphuric acid is applied, it instantly inflames. On this principle are prepared the newly-invented instantaneous lights.

EXP. 106.

Rub together ten grains oxymuriate potash, No. 31, and one phosphorus, No. 30, this, on being struck upon an anvil, produces a most violent detonation.

EXP. 107.

Rub together ten grains oxymuriate potash, No. 31, and four sulphur. If a little of this is

taken on the point of a knife and thrown into sulphuric acid, No. 5, a beautiful colour of flame will be perceived.

EXP. 108.

Mix gently together ten grains of oxymuriate potash, No. 31, and one of phosphorus. This, on being thrown into sulphuric acid, inflames and detonates violently.

EXP. 109.

Rub together, in a mortar, eight parts of sulphuret antimony, six nitrate potash, and one muriate soda (common salt). If a red hot iron is thrust into this mixture, a dreadful conflagration ensues; when this ceases, the residuum is in appearance like liquid fire, which on being freed from the scoriæ, is the article termed Crocus, or Liver of Antimony.

EXP. 110.

Put powder of fusion, already noticed, with a few shreds of copper, into a walnut-shell, covering the metal up with the powder, and set fire to it. The copper will melt, and the powder burn vividly, without injuring the shell.

EXP. 111.

Take of the fulminating powder, and lay a lit-

tle on a fire shovel; by holding it over the fire it explodes violently.

EXP. 112.

Dissolve 100 grains of mercury in an ounce and a half of nitric acid, and when the solution is completely effected, pour upon it gradually two ounces of alkohol, No. 26; a violent action takes place, nitric æther is disengaged in abundance, and fulminating mercury is precipitated, which requires to be speedily washed and dried upon blotting paper in a cool and dark place.

EXP. 113.

Wrap three or four grains, at most, of fulminating mercury in a piece of writing paper, which, on being struck with a hammer, explodes with a loud disagreeable noise.

EXP. 114.

If melted glass be dropped into water, it assumes an oval form, with a kind of tail resembling a retort; these have been termed Prince Rupert's drops. They have the singular property, that if a portion of the tail be broke off, the whole bursts into powder, accompanied with a slight explosion, and a considerable shock is communicated to the hand that grasps it.

EXP. 115.

Mix one ounce semi-vitrified oxid of lead (litharge) with one drachm muriate of ammonia, No. 37, and submit the mixture to a red heat, in a clean tobacco-pipe; when thoroughly mixed pour it into a metallic cup, and you will have a true muriate lead, of a bright yellow color. This is the Patent Yellow.

EXP. 116.

If an ounce of red lead be rubbed with half a drachm of charcoal, and submitted to an intense heat in the bowl of a tobacco-pipe, on being poured out the result will be metallic lead completely revived.

EXP. 117.

Red lead exposed to an intense heat, and poured out when melted, will run into a kind of metallic glass. This is an instance of the vitrification of metals.

EXP. 118.

To a solution of sulphate oxide, add some carbonate of potash, No. 4: a piece of white cloth dipped in this comes out blue. If a piece of yellow cloth be dipped in it, it is rendered green; or a piece of red will be changed to purple.

EXP. 119.

Boil cochineal with a few grains of supertartrite potash (cream tartar), a crimson solution will be formed. By the addition of muriate tin, No. 16, the coloring matter will be precipitated of a beautiful scarlet. By this, or a similar process, carmine is prepared.

EXP. 120.

Take a piece of blue linen, and spot it with muriate tin, No. 16, then immerse it in oxymuriatic acid for a few hours, the linen will be completely bleached.

EXP. 121.

Dissolve four drachms of sulphate iron in a pint of water; to this add six drachms lime, and two indigo; stir the mixture frequently for twelve hours. If a piece of calico be dipped in this mixture, it comes out green, and on exposure to the air becomes a permanent blue.

EXP. 122.

If a piece of calico be immersed in a weak solution of sulphate of iron, No. 13, and when dry, washed with a solution of carbonate of potash, No. 4, it remains of a permanent buff colour.

EXP. 123.

Add to a solution of sulphate indigo, a little muriate tin, the whole becomes green.

EXP. 124.

Write with muriate of cobalt, No. 42, in the cold the writing will be invisible, but on holding it to the fire, it appears of a beautiful green.

EXP. 125.

Write, or draw characters with acetite of cobalt, the writing in the cold is invisible, but on holding it to the fire it becomes blue.

EXP. 126.

Write with a solution of sulphate iron, No. 13, this will remain invisible till washed with some Tinct. galls, No. 15, which turns it instantly black.

EXP. 127.

In the same manner as the last, write with sulphate iron, No. 13, by washing the letters with prussiate of potash, they become immediately blue.

EXP. 128.

Write with nitrate bismuth, the letters become visible by being dipped in water.

EXP. 129.

Write with a solution of acetite lead, No. 18, the letters become intensely black, by being rubbed over with a solution of sulphuret potash, No. 17, or sulphuret ammonia, No. 33, by being exposed to the action of hydrogen gas.

EXP. 130.

Dip a piece of white calico in a solution of sulphate iron, and suffer it to dry; then imprint upon it figures with citric acid dissolved in water; let this also dry, be washed in clean water, and afterward boiled in a decoction of logwood; the ground will be dyed black, but where the acid has been, it remains beautifully white.

EXP. 131.

If citric acid be dropped upon any kind of buff colour, the dye will be completely discharged.

EXP. 132.

Litmus paper dipped in acetous acid becomes red; this, when dried, is the most sensible test of sulphuric acid. According to Bergman, one part of acid in thirty-five thousand parts of water may be detected by it. The paper thus reddened is a most delicate test for alkalies; the red disappears, and its original blue is restored.

EXP. 133.

Writing with muriate of copper is not visible till held to the fire, when it appears of a beautiful yellow.

EXP. 134.

Fill a tobacco-pipe with powdered coal, and cover the bowl over with sand, place it in a common fire, and carbonated hydrogen gas will be disengaged, which burns on the application of a lighted taper, forming an artificial gas light.

EXP. 135.

Dissolve equal parts of submuriate antimony and phosphate lime, in the smallest quantity possible of muriatic acid, and then pour the solution in water, alkalized with a sufficient quantity of pure ammonia, No. 12, an abundant precipitate will be formed. This is the most certain mode of making the Pulvis Antimonialis, or James's Powder.

EXP. 136.

Dissolve sulphuret antimony in nitro-muriatic acid, a violent effervescence ensues; after it ceases, pour the clear solution into water, slightly alkalized, a white powder instantly precipitates. This is the submuriate antimony. When washed, it becomes the Diaphoretic Antimony.

EXP. 137.

Upon acetite potash, (Sal Diureticus) pour half its weight of sulphuric acid, a violent effervescence arises. By the application of heat, pungent acetic acid arises, although the two substances were void of smell.

EXP. 138.

Rub together in a mortar equal parts of muriate ammonia, No. 37, and carbonate potash, No. 4, both perfectly inodorous, but yielding on an union a very pungent compound. This aromatized, makes the pungent smelling-bottle.

EXP. 139.

Mix two ounces of sulphuric acid, No. 5, with an equal quantity of water, and add to it rather more than an ounce of carbonate potash, No. 4, dissolved in a small quantity of water. On mixing them together, a most violent action takes place, and the whole becomes solid; the salt formed is sulphate potash, vulgarly termed Sal Polychrest. In this experiment two limpid solutions produce a solid compound.

EXP. 140.

Pour nitrate bismuth into water, slightly alkalized with carbonate potash, an abundant precipitate is formed. This precipitate, an oxyd of bis-

muth, is much used as a cosmetic, known under the name of Majestry Bismuth. Mixed with an equal portion of French chalk, it has been much extolled as a face powder; but unfortunately for those who accustom themselves to this baneful practice, it has the property of turning black immediately on coming into contact with sulphuretted hydrogen, or sulphureous gas, or the fume arising from a match, &c.

EXP. 141.

To nitrate of mercury, No. 39, add some water, alkalized with carbonate of ammonia. These two colorless fluids produce an ash-coloured precipitate. This is the Grey Oxyd of Mercury of the College.

EXP. 142.

Write upon linen with nitrate of silver, No. 34, which, when dry, is invisible; but, on being again wetted, and held over a vessel containing sulphurate ammonia, or over the fume arising from a match, the silver will be revived and shine with metallic splendor.

EXP. 143.

Wet a piece of linen with some carbonate soda, No. 8. and, when dry, write upon it with a solution of nitrate silver, No. 34; by exposing the

writing to the air, it soon becomes black, and which nothing can remove. On this is founded Permanent Ink-making.

EXP. 144.

Put into a Florence flask, a little carbonate ammonia, and place the flask in some hot water, the heat of which will soon cause the ammonia to rise, and attach itself to the upper part of the vessel. This is an example of sublimation.

EXP. 145.

Rub together in a mortar some sulphate soda, (Glauber's salt) and acetite of lead. The mixture of these two solid substances produces a fluid.

EXP. 146.

Upon a little fresh calcined magnesia, pour some concentrated sulphuric acid; in an instant sparks will be thrown out, and the mixture will be completely ignited.

EXP. 147.

Make into a paste with water, a few pounds of sulphur and iron filings, bury it under ground, in a short time combustion will take place, and form a kind of artificial earthquake.

EXP. 148.

Shake together in a phial some water and olive

oil, no union will take place, but by adding a solution of potash, No. 11, an intimate combination of the materials takes place, and a perfect soap is formed.

EXP. 149.

Put into a Florence flask two or three teaspoonfuls of æther, and fill it with some colored water; on inverting the flask in a vessel of water, and pouring some hot water upon its bulb, the æther will be expanded by the heat, and displace the water.

EXP. 150.

If two or three tea-spoonfuls of æther be tied up in a wet bladder, and a little hot water poured upon it, the æther will expand and completely inflate the bladder.

EXP. 151.

Fill a Florence flask about two-thirds full with water, and place it in a sand heat until it boils; at this instant remove it from the fire, cork it air-tight, and by wrapping a cold wet cloth round the flask, the water again begins boiling, the rationale of the experiment is, while the water was boiling, aqueous vapour filled the upper part of the flask; the wet cloth being wrapt round it, it becomes condensed, and consequently a vacuum is formed,

and from the weight of the atmosphere being removed it boils at a much lower temperature.

EXP. 152.

Place a lighted taper within a wide mouth vial, then take a vial of carbonic acid gas, and cautiously pour it into the jar containing the taper. This being an invisible gas, the operator will appear to invert an empty vessel, but it instantly extinguishes the light.

EXP. 153.

Put a little warm and dry powdered charcoal into a tea-cup, and pour over it some strong nitric acid, No. 7, combustion will immediately ensue.

EXP. 154.

If nitric acid be poured upon a mixture of oxymuriate potash and phosphorus, flashes of fire will be emitted at intervals, for some considerable time.

EXP. 155.

Put into a vial a small piece of phosphorus, and fill it about one-third full with olive oil, cork the vial; whenever the cork is drawn in the dark sufficient light will be evolved to shew the upon a watch.

EXP. 156.

Pour upon muriate of soda, in a saucer, some sulphuric acid, No. 5, in another about two parts quicklime, and one muriate ammonia, adding to these a small quantity of boiling water; each of these will appear to disengage invisible gases, but the moment they come in contact the operator will be enveloped in a dense white smoke.

EXP. 157.

Pour upon some iron filings a small quantity of nitric acid, No. 7, no action will take place, but the moment a few drops of water are added, a very violent effervescence ensues, the acid is rapidly decomposed, and the metal is dissolved.

EXP. 158.

Add to a chalybeate water, or water holding iron in solution, a little succinate ammonia, a precipitate of succinate of iron is immediately formed.

EXP. 159.

If copper filings be added to sulphur in a state of fusion, heat will be evolved.

EXP. 160.

Pour some nitrate mercury, No. 39, upon a piece of bright copper, and gently rub it with a piece of

EXP. 161.

cloth, the mercury will be precipitated and adhere so firmly to the copper as to be completely silvered.

EXP. 162.

If a solution of muriate of gold be added to a solution of muriate of tin, both being diluted with water, the gold is precipitated of a purple color, forming that beautiful pigment called Powder of Cassius.

EXP. 163.

If to a solution of sulphate zinc a little pure ammonia be added, the zinc is instantly precipitated in the form of a white mass, which, on being agitated, is instantly redissolved.

EXP. 164.

Dissolve some oxymuriate mercury in water, and add to it a solution of potash, No. 11; by mixing these colorless fluids a deep orange precipitate is produced.

EXP. 165.

To the orange-colored precipitate formed in the last experiment, add a few drops sulphuric acid, No. 5, which immediately restores it to its original transparency.

EXP. 166.

Prepare two vials, into one put a little sulphuric acid, No. 5, and into the other a little plain water; take one in each hand, and no sensible warmth will be felt, but on mixing them together a strong sensation of heat will instantly be perceived.

EXP. 167.

Take a vial in one hand, containing some muriate ammonia, No. 37, and add to it some water; on shaking the mixture, a strong sensation of cold will be felt.

EXP. 168.

Boil one pound of recent slaked lime with two pounds carbonate soda, in a gallon and half of water, until such time as an ounce of the filtered lixivium weighs eleven drachms Troy; then beat one part of this lixivium with two parts olive oil, in a glass mortar, repeatedly from time to time; which after three or four days becomes consistent, forming a hard andwhite soap.

EXP. 169.

Fill a glass tube, with a bulb, with water, and suspend it by a string; if the bulb be frequently moistened with sulphuric acid, No. 5, the water will soon be frozen, even in summer.

EXP. 170.

If the glass tube, mentioned in the last experiment, be immersed in a mixture formed of five drachms muriate ammonia, No. 37, and five drachms nitrate potash, dissolved in two ounces of water, it will be speedily frozen. Combinations of this kind are termed Frigorific Mixtures.

EXP. 171.

If a teaspoonful of boracic acid, be added to a little alkohol, No. 26, and set fire to, they burn with a beautiful green flame.

EXP. 172.

If alkohol be inflamed with a little pure strontia, a purple flame will be produced.

EXP. 173.

With barytes alkohol burns with a brilliant yellow flame.

EXP. 174.

If oxide of cobalt be dissolved in ammonia, No. 12, a red solution is formed, different in color to all other metallic solutions.

EXP. 175.

If nickel be dissolved in nitric acid, No. 7, an

elegant green solution is produced, much used in coloring porcelain.

EXP. 176.

If sulphuret antimony be dissolved in nitro-muriatic acid, and tinct. galls added to the solution, a yellow precipitate is formed.

EXP. 177.

Add to some alkohol, No. 26, a few grains of oxymuriate potash, No. 31. This mixture, on the addition of a few drops sulphuric acid, No. 5, instantly bursts into flame.

EXP. 178.

Take two glasses, each containing a colorless solution of nitrate copper, No. 36, drop into one a little pure ammonia, No. 12, and into the other some arseniate potash, one will produce a beautiful green precipitate, the other a sapphire blue.

EXP. 179.

Dip a piece of calico into a solution of acetate lead, No. 18, and then drop a solution of sulphuret potash, No. 17, upon it. The lead will gradually revive, and will speedily be reduced to its metallic state.

EXP. 180.

Immerse a slip of white silk in a solution of sul-

phuret potash, No. 17, in alkohol, No. 26. If upon this, a solution of sulphate of manganese, No. 21, be dropped, films of metallic manganese, bright as silver, will instantly appear.

EXP. 181.

Immerse in a solution of muriate tin, No. 16, a strip of silk, and expose it while wet to the fumes of sulphuretted hydrogen gas, or hold it over a bottle of sulphuret ammonia, No. 33, (reduced) tin of great splendor will immediately cover the surface.

EXP. 182.

Silk immersed in a solution of muriate arsenic, and treated in the same way, will speedily be covered with resplendent metallic arsenic.

EXP. 183.

Write upon silk with a solution of muriate gold, and expose it while wet to the fumes arising from a burning match, the writing in a few seconds will be covered with a coat of gold, and which remains permanent.

EXP. 184.

Suspend in a solution of nitro-muriate gold, a small piece of phosphorus, No. 30, freed from moisture; in a few minutes the phosphorus becomes covered with gold.

EXP. 185.

Immerse a piece of silk in phosphoric æther, when the æther has evaporated apply a solution of nitro-muriate of gold, No. 46, the silk will immediately be covered with metallic gold.

EXP. 186.

Proceed as in the last experiment, using a solution of nitrate silver, No. 34, in the place of muriate of gold, and the silk will be covered brilliantly with metallic silver.

EXP. 187.

To a solution of nitrate silver, No. 34, add a little oil of turpentine, shake the mixture and cork it closely; submit it then to the heat of boiling water for an hour, when the metal will be revived, and the inside of the vial will be beautifully silvered.

EXP. 188.

Shake upon an anvil six grains sulphuret antimony, with three of oxymuriate potash, No. 31, it fulminates with a loud report, emitting a flash like lightning.

EXP. 189.

When sulphuret antimony is fused in a crucible it forms a beautiful transparent glass, termed in pharmacy, vitrified, or Glass of Antimony.

EXP. 190.

If nickel be dissolved in ammonia, No. 12, a blue solution will be formed, which, by the addition of nitric acid, No. 7, instantly becomes green.

EXP. 191.

If to the green solution formed in the last experiment, ammonia be added, the original blue color will be reproduced.

EXP. 192.

Dip a piece of polished iron, as the blade of a penknife, into a solution of sulphate copper; the iron will be completely covered with copper.

EXP. 193.

Drop upon a piece of iron a drop of nitric acid, No. 7, no effect will be produced, but if the acid be dropped on a piece of steel an indelible black spot remains. This affords a ready method of distinguishing steel from iron.

EXP. 194.

Take two vials, each containing some nitric acid, No. 7; expose one of them for an hour to the direct rays of the sun. If a little black oxide of manganese be now put into each, it will be readily dissolved by the one, and not affected by the other.

EXP. 195.

Into a vial of water put a few filings of zinc, and a small piece of phosphorus, No. 30, then convey a little sulphuric acid, No. 5, by means of a tobacco-pipe, to the articles at the bottom, phosphuretted hydrogen gas will be generated, and takes fire as it comes in contact with atmospheric air.

EXP. 196.

Upon a small piece of phosphuret of lime, let fall a single drop of muriatic acid, diluted with a small quantity of water, small balls of fire will dart from the mixture, attended with an extreme fetid smell.

EXP. 197.

Cut twenty grains of phosphorus very small, and mix it with forty grains of granulated zinc. If this be added to a mixture of four drachms of water, and two sulphuric acid, bubbles of inflamed phosphuretted hydrogen gas will arise in rapid succession, forming an aqueous fountain of fire.

EXP. 198.

Upon a basin of water pour about a teaspoonful of æther, by bringing a lighted taper in contact with the surface, the æther will burn a long time on the surface of the water.

EXP. 199.

By dropping a solution of sulphate iron into a solution of nitro-muriate of gold, the latter metal will be precipitated; in which state it is often employed in gilding china.

EXP. 200.

To a solution of gold add a fourth part æther, shake them together, and wait till the fluids separate. The upper stratum is ethereal gold, which may be poured off. If any polished instrument be plunged into this ethereal solution, and dipped immediately in water, the surface will have acquired a coat of pure gold. This is an elegant method of preserving polished steel from rust.

EXP. 201.

If a small piece of nitrate of silver be placed on a piece of burning charcoal, the salt immediately deflagrates, throwing out beautiful scintillations, and the surface of the charcoal will be richly coated with metallic silver.

EXP. 202.

To a solution of nitrate mercury, No. 39, add a solution of subborate soda; these are both colorless fluids, but produce by their union a bright yellow precipitate, borate mercury.

EXP. 203.

Add to a solution of sulphate copper, a little pure ammonia, No. 12, a bluish white precipitate will be formed, which on agitation is redissolved, forming a beautiful blue liquid, termed Aqua celestis.

EXP. 204.

Write with a dilute solution nitrate of bismuth, and, when dry, wash the writing with sulphuret of potash, No. 17, which instantly blackens the oxide, and renders it visible.

EXP. 205.

Drop a piece of phosphorus into a tumbler of hot water, and force from a bladder with a stop-cock, a stream of oxygen gas, directly upon it. This affords a brilliant combustion under water.

EXP. 206.

Mix some dry carbonate of soda with some crystallized citric acid; no action takes place, but the moment water is poured on them, an effervescence ensues. This shews the necessity of one body being in a state of fluidity to promote some chemical decompositions.

EXP. 207.

If metallic arsenic be mixed with a few zinc filings, and diluted sulphuric acid poured upon them, arseniated hydrogen will be disengaged, which burns with a lambent white flame.

EXP. 208.

A stream of inflamed arseniated hydrogen gas, burns in oxygen gas with a blue flame, inconceivably brilliant.

EXP. 209.

Triturate in a mortar a solid amalgam of lead and mercury, with an amalgam of bismuth. They instantly become fluid.

EXP. 210.

Mix a solution of muriate of soda with a solution of nitrate silver, No. 34, a material decomposition takes place, muriate silver is precipitated, and nitrate soda remains in solution.

EXP. 211.

Take the white precipitate of muriate of silver, formed in the last, and expose it to the sun's rays, in a short time it becomes entirely black. This experiment shews the action light has upon metallic oxides.

EXP. 212.

Add a few drops of tinct. soap, No. 44, to a little distilled water, no effect will be perceived; but if added to hard water, it instantly becomes turpid. This is a good test for ascertaining the purity of spring water.

EXP. 213.

To a solution of sulphate of copper in boiling water, add a hot solution of muriate of ammonia, No. 37, a quadruple salt will be formed, which gives a yellow color to the solution while hot, but on cooling becomes green.

EXP. 214.

Rub in a mortar equal parts of sulphate magnesia, and muriate ammonia, No. 37; these two solid substances first become soft, and on standing will become fluid.

EXP. 215.

A piece of phosphorus about the size of a large pin's head, enveloped in a piece of cotton, and struck with a hammer instantly sets fire to the cotton. Paper, linen, &c. may be fired by the same means.

EXP. 216.

Wet a piece of lump sugar with phosphuretted

ether, and put it into a basin of warm water, the ether immediately evaporates, and a beautiful phosphorescent light appears upon the surface of the water, and which in the dark is extremely curious, greatly resembling the undulation of the waves.

EXP. 217.

Write with a solution of sulphate of indigo, and near to the same line write with a solution of acetate lead, No. 18, the one is blue, the other invisible; by washing them over with a clean camel hair brush dipped in sulphuret ammonia, No. 33, the blue writing disappears, and the invisible turns black.

EXP. 218.

Dissolve about 20 grains of oxymuriate potash, No. 31, in 2 oz. muriatic acid, No. 6; by means of this solution almost every color may be removed from linen, and restored to its original whiteness, such as ironmoulds, wine stains, grease spots, &c.

EXP. 219.

Put into a bladder, furnished with a stop cork, or a piece of tobacco-pipe, about two teaspoonfuls of ether, pour hot water upon it, or hold it to the fire till the bladder becomes inflated, and by putting a

lighted taper to the end of the pipe, and pressing the bladder, the vapour will continue to burn as long as any remains.

EXP. 220.

Mix four grains of sulphur and ten nitrate silver; if this be struck upon an anvil with a cold hammer, inflammation takes place without detonation.

EXP. 221.

If the mixture in the last experiment be struck with a warm hammer, a loud detonation ensues, and the silver reduced to its metallic state.

EXP. 222.

Immerse in a solution of nitrate of silver, some strips of copper, the silver will be precipitated in a metallic state. If to the remaining solution a piece of iron be added, the metal will be dissolved, and the copper precipitated, yielding an example of peculiar affinities. See Chemical Laws.

EXP. 223.

Form an amalgam with four parts silver leaf, and two mercury, and dissolve this amalgam in dilute nitric acid, then add water to the solution equal to thirty times the weight of metals em-

ployed. If into an ounce of this solution there at any time be added a small piece of soft amalgam of silver, filaments of reduced silver will shoot from it, and extend upwards in the form of a shrub. This is termed the Tree of Diana.

EXP. 224.

Pour muriate of tin, No. 16, into a green solution of muriate copper, No. 24, and a white precipitate will be formed.

EXP. 225.

If muriatic acid be added to the white precipitate of the last experiment, it instantly dissolves, forming a colorless solution.

EXP. 226.

On some black oxide of manganese pour nitric acid, No. 7, no solution will be effected, but if a little sugar be added the metal is speedily dissolved.

EXP. 227.

Digest a solution of sulphate iron, No. 13, with some iron filings; when filtered add to it a few drops of prussiate potash, a white prussiate of iron will be precipitated.

EXP. 228.

If to a solution of iron, prepared as in the last

experiment, a little nitric acid be added, then the addition of prusssiate potash, produces a deep blue prussiate of iron.

These experiments tend to shew the difference of color in metallic oxides, according to their degree of oxidizement.

EXP. 229.

Write with dilute sulphuric acid; the writing is invisible until held to the fire.

A number of ingenious and interesting experiments, shewing the necessity of the presence of water in the reduction of metallic substances, &c. may be seen in Mrs. Fulham's Essay on Combustion. The student will find by repeatedly practising the foregoing experiments, and examining carefully the phenomena that attend them, the utmost advantage in his acquirement of chemical knowledge. He will discover that no effect, however trivial or striking, can take place but by some previously established law of unerring Naure.

CHEMICAL GLOSSARY.

Acetates, are salts formed with the acetic acid.

Acetites, are salts formed with the acetous acid.

Acids, oxygenized, are acids combined with an additional quantity of oxygen.

——, hyper-oxygenized, are acids oxygenized to a maximum.

Aeriform fluids. Gases—fluid substances with an additional portion of caloric.

Affinity. Attraction, a propensity bodies have to unite with each other.

Aggregation. The cohesive power that keeps bodies from falling to pieces.

Alkalies, are a class of peculiar substances, which have a strong tendency to combination, they render oil miscible with water, and unite with all acids forming alkaline salts.

Alkohol, a name given to highly rectified spirit of wine.

Alloy, is a combination of any two metals excepting mercury.

Alumine. An earth, the base of the alum of commerce.

Amalgam. A mixture of mercury with any other metal.

Ammonia. The volatile alkali.

Annealing. The art of rendering substances tough, which are naturally hard and brittle.

Analysis. The seperation of bodies into their constituent parts.

Aqua regia. A mixture of nitric and muriatic acid, the only solvent of gold.

Argillaceous. Earths containing alumine.

Arseniates. Salts formed with the arsenic acid.

Arseniates. Salts formed with the arsenious acid.

Attraction. Affinity.

Azote. Nitrogen.

—— Gas. Nitrogen rendered aeriform by caloric.

Barometer. An instrument which shews the variation of the pressure of the atmosphere.

Base salifiable. A term applied to denote the substance that is combined with acids in the formation of salts.

Bath sand. A bed of sand on which a retort or

any other vessel is placed that requires a greater heat than can be communicated by boiling water.

Bath water. Is a vessel filled with boiling water, in which other vessels are placed that require application of a gentle heat.

Baldwin's phosphorus. A substance that shines with a white light in the dark on exposure to atmospheric air, is formed by exposing nitrate lime to a red heat.

Bell metal. Is copper united with one-sixth part tin.

Benzoates. Salts formed with the Benzoic acid.

Bolt head. Matrass.

Bologna phosphorus. These substances are termed solar phosphoruses; they shine like burning coals in the dark.

Borates. Salts formed with the boracic acid.

Brimstone. Sulphur.

Bleaching. A process employed for removing vegetable colours, whitening of linen, &c.

Brass. A compound of copper and zinc.

Calamine. Native oxid of zinc.

Calcareous, or *Cretaceous.* These terms are applied to describe all combinations of lime.

Calcination. Is the application of heat to metallic or other substances.

Calomel. The old name for submuriate mercury.
Caloric. Chemical term for the matter of heat.
Caloremeter. An instrument for ascertaining the quantity of disengaged caloric.
Calx. An old term for metallic oxids.
Camphorates. Salts formed of the camphoric acid.
Candle philosophical. The combustion of hydrogen gas, through a small tube.
Caoutchouc. Elastic gum, Indian rubber.
Capillary. The rise of a fluid in small tubes owing to a peculiar kind of attraction termed capillary.
Capsules. Saucers made of clay used for roasting ores.
Caput mortuum. Residuum.
Carbon. The basis of charcoal which, has never been obtained pure but in the diamond.
Carbonates. Salts formed with the carbonic acid.
Carburets. A combination of carbon with some other substance.
Cement. A kind of glue. See lute.
Cerium. A newly discovered metal.
Chalybeate. Any thing impregnated with iron.
Charcoal. A name given to burnt wood. Is chemically speaking an oxid of carbon.
Chrome. A newly discovered acidifiable metal.
Chromates. Salts formed with the chromic acid.

Cinnabar. Native sulphuret mercury when levigated forms the article termed vermilion.

Citrates. Salts formed with the citric acid.

Cohesion. Synon. Aggregation.

Columbium. A newly discovered acidifiable metal.

Columbates. Salts formed with the columbic acid.

Combustible. Bodies that are capable of decomposing oxygen, uniting with its base, and disengaging light and caloric, are thus termed.

Combustion. Is the absorption of oxygen by combustible bodies.

Corrosive sublimate. The old name for the oxymuriate mercury.

Concentration. A process by which fluids are made stronger by the evaporation of a portion of water they contain.

Condensation. Is the subtraction of caloric from aqueous vapors, by which means they resume the original state of fluidity or solidity.

Crucible. Is a vessel in the form of an inverted cone, formed generally of some kind of earth, and capable of standing an intense heat.

Crystallization. Is a property many earths, salts, and metallic substances have of passing

from a fluid to a solid state, assuming certain determinate geometrical figures.

Cupellation. Is a process by which copper, lead, &c. are separated from gold.

Decoction. The boiling of any vegetable in water.

Decomposition. The separation of the component parts of bodies by chemical means.

Deflagration. A sudden combustion produced whenever nitrate potash is exposed to a red heat, in combination with an inflammable substance.

Deliquescence. A property some substances have of attracting humidity from the air and becoming moist.

De-oxidize. To deprive a body of oxygen.

Depuration. The separation of a liquid from its fæces or dregs.

Detonation. An explosion.

Digestion. Maceration.

Disregate. Any substance that has its attraction of aggregation destroyed by mechanical means, is termed a disregate.

Distillation. A process by which the volatile parts of a substance are separated from the more fixed, and preserving both in a separate state.

Ductility. A quality some bodies have of being drawn out to a certain length without laceration.

Edulcoration. Is the purification of substances by washing with water.

Effervescence. Is the sudden disengagement of a gaseous substance, generally proceeding from the decomposition of some carbonate by the influence of an acid.

Efflorescence. When certain salts are exposed to a warm atmosphere, they lose a portion of their water of crystallization, so as to admit of being reduced to powder.

Elastic fluids. Æriform fluids.

Elective affinity, is synon. with affinity. It is a term used by Bergman, who imagined that the particles of some bodies had a preference for other particular bodies; hence it acquired the name elective.

Elements. A name given to those bodies that admit of no further decomposition. It is synon. with "principles," "simple substances," &c.

Electriation. Is the separation of the lighter particles of bodies by means of water.

Empyreumar. An extreme fetid smell, that

arises from the burning of animal and vegetable substances in close vessels.

Essential salts. The saline particles found in plants which are separated by boiling in water and subsequent evaporation.

Ethers. Are combinations of acids with alkohol.

Etiolation. Is the shielding of vegetables from the influence of light.

Evaporation. Is the conversion of fluids into vapour by the application of heat.

Eudiometer. An instrument employed for ascertaining the purity of atmospheric air.

Exsiccation. Drying.

Extract. Is a decoction of a vegetable substance reduced by evaporation to the consistence of honey.

Fecula. The nutritious part of grain.

Fermentation. A spontaneous change that all vegetable matter undergoes at a certain temperature.

Filtration. The depuration of liquid substances by passing it through bibulous paper.

Fluates. Salts formed with the fluoric acid.

Flux. Is an article used to promote the fusion of metallic substances.

Fulmination. Explosion.

Fusion. Is a solid body rendered fluid by the application of heat.

Galena. Native sulphuret lead.

Gallates. Salts formed with the gallic acid.

Gas. A permanent elastic fluid.

Gasometer. An apparatus for collecting and measuring the gases.

Gluten. A vegetable substance somewhat similar to gelatine or animal jelly.

Granulation. This process consists in pouring melted metals into water for the purpose of dividing them.

Hepar. An old name for the alkaline sulphurets.

Hepatic gas. The old name for sulphuretted hydrogen.

Hydrogen. An element, one of the constituent parts of water.

Hydro-carbonates. Are combinations of carbon with hydrogen.

Hydro-sulphurets. Substances united with sulphuretted hydrogen.

Hydro-oxydes. Metallic oxides and water.

Hydrometer. An instrument for ascertaining the specific gravity of fluids.

Hygrometer. An instrument for ascertaining the quantity of water in the atmosphere.

Jargone, synon. *Zircone.* A newly discovered earth.

Ignition. A species of combustion unattended by inflammation.

Incineration. The burning of vegetables.

Inflammation. A phenomenon that generally attends combustion.

Infusion. Maceration of vegetable substances in water.

Integrant, synon. with *disregate.* By Pulverization a body is divided into its integrant parts.

Iredium. A newly discovered metal.

Kali. A marine plant from whence the mineral alkali is obtained.

Lactates. Salts formed with the lactic acid.

Lake. The colouring matter of cochineal, or some other vegetable substance with alumine.

Levigation. Is the reducing a body to an impalpable powder.

Litharge. The old name for the semi-vitrified oxide of lead.

Lixivium. An alkaline solution.

Lutes, synon. *Cements.* They are used to prevent the escape of any elastic fluid during distillation.

Maceration, Infusion.

Malates. Salts formed with the malic acid.

Maleability. A property some metals have of being extended and flattened by hammering.

Martial, synon. with *Chalybeate.*

Massicot. The old name of the yellow oxid of lead.

Matrass. A glass vessel of a shape similar to a Florence flask.

Menstruum, is synon. with *Solvent.* As alkohol is a menstruum or solvent for resins, &c.

Metallurgy. The art of extracting metals from their ores.

Mineralogy. Is the art of distinguishing ores, and describing them with accuracy and precision.

Minium. The old name for red oxid of lead.

Molybdates. Salts formed with the molybdic acid.

Mordants. Are substances used by dyers. for fixing certain colours.

Mucites. Salts formed with the mucous acid.

Muriates. Are salts formed with the muriatic acid.

Natron, synon. *Soda.* The old name for mineral alkali.

Neutralize. When two or more substances unite

and mutually destroy each other's properties. They are said to neutralize each other.

Nitrates. Salts formed with the nitric acid.

Nitrites. Salts formed with the nitrous acid.

Nitro-muriatic acid, synon. *Aqua regia.*

Nitrogen, *Azote.*

Ore. A metallic earth.

Orpiment. An old name for sulphuret arsenic.

Oxalates. Salts formed with the oxalic acid.

Oxide. A combustible substance, combined with a less proportion of oxygen than is necessary to produce acidity.

Oxidizement. The process by which a substance becomes united to oxygen, without producing acidity.

Oxygen. An element that constitutes a part of water and atmospheric air.

Oxygenize. The acidification of a substance by oxygen.

Oxygenizement. The production of acidity by oxygen.

Pellicle. A thin skin that forms on the surface of saline solutions during their evaporation.

Phosphates. Salts formed with the phosphoric acid.

Phosphites. Salts formed with the phosphorous acid.

Phosphurets. A combination of phosphorus with some other substance.

Photometer. An instrument for measuring the relative intensity of light emitted by luminous bodies.

Plumbago. Carburet iron.

Pneumatic. Relating to the airs and gases.

Precipitate. When a substance is dissolved in a fluid and falls down by the addition of a third body. The substance so falling is termed a precipitate.

Prussiates. Salts formed with the Prussic acid.

Putrefaction. The last fermentive process of nature, by which organized bodies are decomposed so as to separate their principles for the purpose of reuniting them by future attractions, for the productions of new compounds.

Pyrites. Native metallic sulpherets.

Pyrometer. An instrument for measuring the intensity of heat.

Quartz. A name given to different siliceous earths.

Quicksilver. The old name for mercury.

Radical, synon. with *Element.*

Reagent, synon. with *Test.*

Realgar. The old name for sulphuretted oxide of arsenic.

Rectification, synon. with *Re-distillation.*

Reduction. Restoration of metallic oxides to the metallic state.

Refrigatory. A contrivance for holding cold water for the condensation of vapor, that arises in distillation.

Regulus. A metal in its pure metallic state.

Repulsion. Is a power that prevents bodies from coming into actual contact, which is thought to be owing to caloric.

Retort. A vessel in the shape of a pear used in distillation.

Rhodium. A newly discovered metal.

Rock crystal. Crystallized silex.

Saccholates. Salts formed with the saccholactic acid.

Saline. Partaking of the nature of a salt.

Salts, neutral. A class of substances formed by the combination of an acid, with some salefiable base.

——, *triple.* Formed by the combination of an acid with two salefiable bases.

——, *saponaceous.* Partaking of the nature of soap.

Saturation. Is the impregnation of a fluid with

any other substance till no more can be received by it.

Sebates. Salts formed with the sebacic acid.

Siliceous earths. Substances containing silex.

Solution. The perfect union of a solid substance with a fluid.

Spelter. Another name for zinc.

Sub-salts. Salts with less acid than is sufficient to neutralize their base.

Suberates. Salts formed with the suberic acid.

Sublimation. A process whereby the volatile parts of bodies are raised by heat, and condense again in a solid form by cooling.

Succinates. Salts formed with the succinic acid.

Sulphates. Salts formed with the sulphuric acid.

Sulphites. Salts formed with the sulphureous acid.

Sulphurets. The combination of sulphur with any other substance.

Super-salts. Salts with an excess of acid.

Synthesis. The reproduction of a substance that has been analyzed.

Syphon. A bent tube for drawing liquids from one vessel to another.

Tartrites. Salts formed with the tartareous acid.

Test. Is an article employed in chemical experiments, to detect the several ingredients of any composition.

Thermometer. An instrument to shew the relative heat of bodies.

Tineal. Another name for borax.

Trituration. The union of substances by friction.

Tungstates. Salts formed with the tungstic acid.

Tutenag. A compound of copper, tin, and arsenic.

Vacuum. A space unoccupied by atmospheric air.

Vapor. Is an aeriform fluid that can be condensed into a liquid state again at the common temperature of the atmosphere. In this respect only it differs from gas.

Vital air, synon. *oxygen gas.*

Vitriols. A class of earthy, alkaline, or metallic substances combined with the vitriolic acid. They are now termed sulphates.

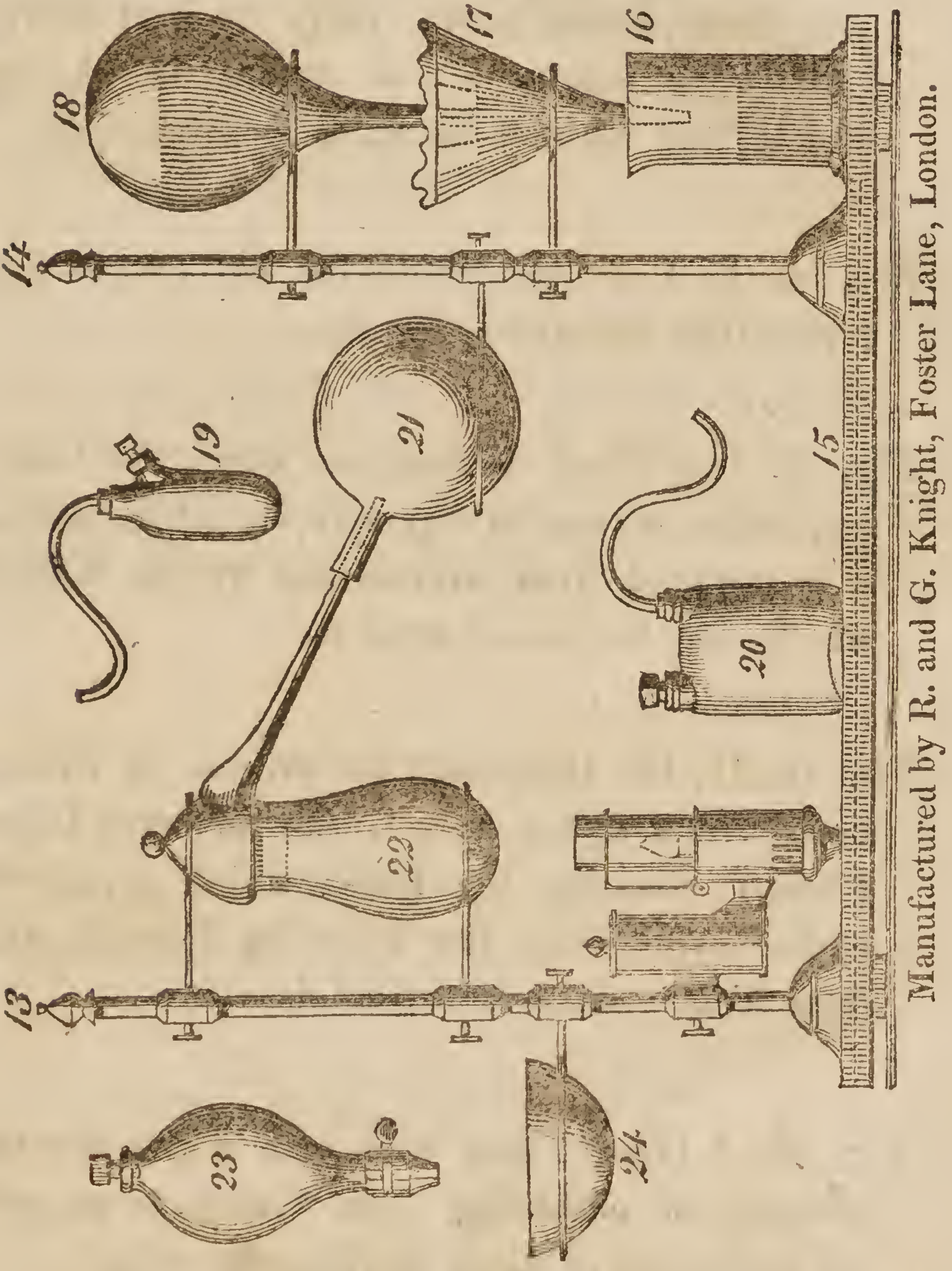
Volatile alkali, synon. carbonate *Ammonia.*

Welding heat. That degree of heat that two pieces of metals may be united by hammering.

Worm tub. A tub with a hollow pewter box in the inside, and the intermediate space filled with water. This apparatus is called a Refrigatory.

Zaffre. An oxide of cobalt.

GUYTON's PORTABLE LABORATORY.



The Portable Laboratory, of Guyton, of which the above is a representation, comprises some of the most essential Articles for performing the principal Operations in experimental Chemistry.

Fig. 13. Represents a Brass Rod supported by a loaded Brass Foot, with three sliding Sockets and Rings, which move freely up and down, and fix by means of a screw; the Lamp may in like manner be fixed at any height.

Fig. 14. Is a similar Stand for the purpose of supporting Receivers, &c. &c.

Fig. 15. Is a Wood Frame, on which the Lamp Apparatus moves in a groove, by which means it is secured from oversetting by the Weight which may be placed upon it.

Fig. 16, 17, 18. Represent the process of Filtration. The upper vessel, (an inverted Glass Flask,) contains the Fluid which gradually is discharged into the Filtering Funnel, and from thence passes into the Glass Jar.

Fig. 19. A Glass Flask with bent Tube, for the purpose of obtaining such Gases as require the assistance of Heat to disengage them.

Fig. 20. A Glass Vessel for the separation of Carbonic Acid Gas from Calcareous Earth.

Fig. 21. and 22. A Glass Alembic or Still and Receiver, with the Lamp applied as in the process of distilling Spirit from Wine.

Fig. 23. A separating Vessel, for the purpose of dividing Oil from Water.

Fig. 24. An Evaporating Basin.

Every other Description of Chemical Apparatus, Furnaces, Stills, &c. may be seen at the manufactory of Messrs. R. and G. Knight, of Foster Lane, Cheapside, London.

THE END.

J. G. Barnard, Skinner-Street, London.